THE
Universal Navigator;
OR,
A COMPREHENSIVE TREATISE OF
NAVIGATION;

CONTAINING,

I. THE moſt uſeful Problems in Geometry, Meaſuring of Plank, Timber Balks, Boxes, and Tunnage of Ships.

II. Trigonometry with its application to the taking of Heights and Diſtances, acceſſible and inacceſſible.

III. Navigation, (viz.) Plain Sailing, Traverſe Sailing, Mercator, Middle Latitude, and Parallel Sailing, with all the ſeveral examples wrought Geometrically, Trigonometrically, by Logarithms, Arithmetically, by Natural Sines and Tangents, Inſtrumentally, and by Tables of Latitude and Departure.

To which is annexed a curious Collection of Queſtions to exerciſe all the above kind of Sailing, with a large and correct Table of Difference of Latitude and Departure, and Meridional parts. Alſo a Table of Latitude and Longitude of Places.

IV. Great Circle Sailing, with a curious Collection of Queſtions applied thereto, ſeveral of which have never appeared in any Treatiſe of Navigation extant.

Oblique Sailing, Turning to Windward, Sailing in Currents, with a Collection of Queſtions both curious, uſeful, and entertaining, to exerciſe the ſame.

V. The Gregorian Calender, ſhewing the beſt method of finding the Prime, Epact, Moon's age, time of High Water, with a large Tide-Table, alphabetically digeſted, the manner of working Obſervations, the beſt Method of finding the variation of the Compaſs. To keep a Sea Journal in the beſt approved method, both in Merchant's Ships and the Royal Navy, alſo to correct the Dead Reckoning by a good Obſervation, by the eaſieſt and beſt approved Method, illuſtrated with full, proper, and practical examples of the ſame, together with all uſeful Aſtronomical Tables, viz. the Sun's Declination, a Table of Logarithms, of Nat. and Artificial Sines and Tangents, with a curious collection of Aſtronomical Problems uſeful in taking Obſervations at any time of the Day, or by two Obſervations, and having the time between them, without regarding the Hour; ſeveral of them have not appeared in any other Author.

With an APPENDIX, ſhewing how to work all the caſes in Navigation by the Pen Arithmetically, without Books, Tables, or Inſtruments.

By WILLIAM CHAMBERS,
Teacher of the Mathematics.

WHITEHAVEN:
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THE

PREFACE.

THERE are already ſo many books of Navigation extant, that it may ſeem impertinent to trouble the world with a new one; ſince ſo many Mathematicians, both at home and abroad, have written on the ſubject; ſome of which being too prolix in the theory, and too ſhort in the practical part; whereas others have in a great meaſure neglected the theory, and alſo delivered the practical rules in ſuch a manner, as they cannot eaſily be comprehended, and much leſs remembred; eſpecially ſince there is ſeldom given the reaſons on which they depend. And there are others which abound both in theory and practice, and yet are too tedious to be taught, and too dear to be purchaſed by many people.

Youth being deſirous to learn the elements from ſhorteſt treatiſes; and afterwards at their own leiſure, may read general ſyſtems in order to complete them. For theſe reaſons I have ventured to publiſh this as a comprehenſive treatiſe, wherein I have made it my chief buſineſs to keep a due medium between the two extreams, into which the ſpeculative writers on the one hand, and the periodical ones on the other, are apt to run. I have laid down all the uſeful rules, and troubled the young Navigator with no more of the theory than is neceſſary to explain them. And as I hope the enſuing work is able to anſwer for its truth and uſefulneſs, ſo I ſhall here take up no more of my

readers time, than to give them a brief account of ſome of the principle articles herein contained, in order as followeth.

Firſt, the young Navigator will find ſixteen problems in plain Geometry, being the moſt uſeful in conſtructing the mathematical figures.

Secondly, To furniſh him with what is uſeful, I have given the general rules for meaſuring ſuperficial figures, as flat ſtone, board, and plank; together with meaſuring of ſolids, as round and ſquare timber, and rules for meaſuring of cubes, parallelpipedons, priſms, cylinders, cones, pyramids and their fruſtums; together with boxes, bales, caſes, and tonnage of ſhips.

Thirdly, Trigonometry, with a geometrical conſtruction of all the lines on Gunter's ſcale, general maxims belonging to right angled triangles, the geometrical and trigonometrical ſolutions of the ſeven caſes of right angled triangles, by logarithms and artificial fines and tangents, by making each ſide Radius. Together with the uſe of right angled plain triangles, in ſeveral problems, about the taking of heights and diſtances of objects, when acceſſible.

Fourthly, NAVIGATION, where the reader is preſented with a ſcheme or projection of the meridian and parallels of the globe in plano, exhibiting how latitude and longitude is accounted.

General rules for the latitude, viz. having both latitudes given, to find the difference of latitude.

2d. Having the latitude of one place and the difference of latitude given, to find the other latitude.

3th. The conſtruction of the plain chart, and to lay down any place by its bearing and diſtance from it, with examples, ſhewing the uſe of the plain chart.

6th, Plain Sailing geometrically, trigonometrically, arithmetically and inſtrumentally, and after the ſix caſes, the young Navigator will find ſix other queſtions, attended with ſome more difficulty than the forgoing.

7th,

7th. Traverſe Sailing, with dividing the Log: in proportion to any glaſs, and proving the half minute glaſs, here the young Navigator will find ſeveral curious queſtions, when projected will produce ornamental figures for the learners book.

8th. Mercator Sailing geometrically trigonometrically, arithmetically and inſtrumentally, to which is added a new caſe, viz. One latitude, diſtance, and differ. of longitude, being given, to find the courſe, difference of latitude, and difference of meridian, alſo to work a Mercator traverſe; the deſcription and uſe of Mercator's chart; Rules for longitude alſo, and to make a chart for a particular voyage, and to prick down the ſeverel courſes on the chart.

9th. Parallel Sailling geometrically, trigonometrically, arithmetically and inſtrumentally; Together with two examples more curious than the former.

10th. Middle Latitude Sailing, wherein the young Navigator will find an eſſay on the ſame whereby the middle latitude is found to agree with mercator in high latitudes north or ſouth; alſo to find the middle latitude between two places, when one is north and the other in ſouth latitude, with variety of examples to exereiſe the ſame.

11th, Next follows a large and correct table of diffeience of latitude and departure, to every point and quarter of a point of the compaſs. A Table of meridional parts, to every degree and minute of the quadrant, for performing the ſeveral caſes in Navigation according to mercator, or more properly Mr. Wright's projection. A Table of the ſun's declination. A Table of the latitudes and longitudes of the principle harbours, headlands, and iſlands iu the world, corrected by the lateſt and beſt obſervations, accounting the longitude from the meridian of London. Rules concerning amplitudes. A Table of Numbers, for finding the proportional parts to the odd minutes of latitude or declination, in finding the ſun's true amplitude. Then follows the Gregorian Kalender, ſhewing how to find the prime, epact, moon's age, ſouthing, and time of high water, with a large tide table, alphabetically digeſted.

12th, To work an obſervation or to find the latitude of the place, by the ſun or ſtars declination, and their zenith diſtance taken by Hadley's quadrant, the common quadrant, or foreſtaff, &c. and here I muſt remember the obſerver, that in order to take an obſervation with accuracy, of the ſun's meridian altitude, that the height of the obſervers eye abo ve the ſurface of the water, makes the obſerved altitude a little to great, as here in the following order.

	Feet		Min.
If the height of the Eye be	3	the Error is	2
	6		3
	11		4
	17		5
	25		6
	34		7
	44		8

Which number of minutes are to be ſubſtracted from the obſerved altitudes, in the fore obſervations (with Hadley's quadrant) to get the true altitudes as to this part. And it being moſt convenient when exactneſs is required in obſerving the ſun's meridian altitude, to obſerve the under or upper limb of the ſun tuching the edge of the ſea, in the horizon, then in the former caſe the ſun's ſemidiameter, viz. 16 minutes, it is to be added, and in the latter to be ſubſtracted from the obſerved altitude, to have the altitude of the ſun's center at the ſame inſtant.

Again, another correction of the ſun's obſerved altitude is required, by reaſon of refraction of the ſun's rays of light, in their paſſage through the atmoſphere, or the body of air ſurounding the globe, by which all the heavenly bodies, viz. the ſun, moon, &c, are made to appear higher above the horizon than they really are, when the altitude taken by the quadrant is accounted the apparent altitude, and muſt have the refraction ſubſtracted from it, to gain the true altitude.

The angles of refraction to be allowed at the ſeveral altitudes of the ſun, are the horizontal refraction equal 33 minutes.	deg.		min.
	1		24
	2		18
	3		14
	4		11
Sun's apparent altitude in deg.	5	Refraction is	9
	6		8
Hence it appears that the horizontal refraction is the greateſt, for refractiong radually decreaſes from the horizon to the zenith, where it vaniſhes.	8		6
	12		4
	16		3
	23		2
	40		1

Here follows an example to make theſe deductions plain, ſuppoſe the meridian altitude be obſerved 40 feet above the ſurface of the ſea, by its upper limb 38 ,37, query the true altitude of the ſun after all deductions are made.

Firſt, The apparent altitude	38 ,37
Height of the equinox 40 feet dept. Subſtract	8
Remains	38 ,29
Refraction at 38 ,87 Subſtract	1
Remains	38 ,28
Sun's ſemidiameter Subſtract	16
Remains the ſun's true altitude	38 ,12

This true altitude taken from 90 ,00 the remainder is the zenith diſtance.

13th. Next follows a table of the ſun's right aſcenſion and uſe of the ſame, with a table of the right aſcenſion in time, and declination of the principal fixed ſtars. A Table of the right aſcenſion and declination of the croſiers, together with the uſe of tables of the ſun and ſtars right aſcenſion, with rules for longitude.

14th, The variation of the compaſs, with all the rules for finding it in any latitude, either north or ſouth, and with either north or ſouth declination. Note, the ſun's true amplitude may be found either by the tables or this proportion, viz. As S. C. Lat. : S. Sun's Declination, : : Radius : to the S. Sun's

true

true amplitude, from East at sun rising, but from West at sun setting; the reader will also find a geometrical construction of the figure for the variation.

15th. The young Navigater is here presented with general rules for keeping a Journal, the Log. book, Leeway and variation, how to account for them and how to try a currant, viz. to find its direction and velocity, the approved method to find which (as has commonly been practised) in voyages to America, or West Indeas, &c. is this,

When there is a smooth sea and not much wind, hoist out your boat and take into it three or four men, with a compass, a log line, and a large log. and half minute glass; also a quoil or two of inch rope (when you are a little from the ship) which fasten to the bool of a large iron pot, then cast over board the pot, letting it sink at least 100 or 120 fathoms, (the more the better) then belaying the rope about the boats item, it will bring her up, and make her ride as if at anchor; then heave your log and turn your half minute glass, as you do in the ship to find her distance run, and as you veer out the log line, set the drift of the log by the compass; so you will know whether there be any currant or not, and if any, how it sets and its velocity. As suppose you find the currant sets east, at the rate of one knot and a half, in half a minute, that its current motion is east 36 miles in 24 hours; but you must observe,

1st. To allow the variation of the compass by the rules here after given.

2d. If the rope be 80 fathoms allow one quarter part, if 100 fathom one fifth part, &c. of the drift of the currant more for the drift of the boat; for though the boat seems to lie still, yet she is found by experience to drive at the same time. Having by the experiment found the quantity and quality of the currant, the ship's true motion may be obtained by the problems in current sailling hereafter delivered.

16th. Rules for correcting the dead reckoning by an observation, with rules to find the meridian distance, all which rules are carefully exemplified in a voyage from Start Point, in Eng-

land

land, to the Iſland Madiera, in which I have diſcovered ſeveral errors in the Journal, given in the Seaman's Daily Aſſiſtance.

17th. The Navigator is preſented with twenty-five curious queſtions, whoſe ſolutions are not to be found in any author yet publiſhed, for the amuſement of the curious.

18th, Oblique Trigonometry, the three other axioms of oblique angled plain triangles, and the ſix caſes thereon depending, performed geometrically, trigonometrically, arithmetically, and inſtrumentally, to which is added ſeveral curious and uſeful problems, ſhewing the uſe of obliqued plain triangles, in taking of heights and diſtances, acceſſible and inacceſſible, from two ſtations taken at pleaſure.

19th. Oblique Sailing, or the doctrine of oblique triangles, applied to a great variety of curious and uſeful queſtions in Navigation; together with turning to windward, ſailing in currants, turning to windward in currants; with a collection of queſtions both curious, uſeful, and entertaining, to exerciſe the ſame.

20th, Great Circle ſailing, with a curious collection of queſtions applied thereto, ſeveral of which have never appeared in any treatiſe of Navigation extant.

21ſt. Next the reader will find a large collection of curious problems in Aſtronomy, uſeful to the Navigator, by which he may find the latitude he is in, at ſix o'clock either morning or evening; or when the ſun is due eaſt or weſt, he may find the latitude of the place and hour of the day, in the forenoon or afternoon. Alſo, by having the ſun's declination, altitude, and azimuth given, he may find the latitude of the place and hour, at any time of the day; or by two obſervation, and having the time between them given, without regarding the hour at either obſervation. With many others too tedious to mention here, all which are done in the moſt eaſy and elegant manner that can be deviſed. Together with a table of logarithms, alſo a table of natural and artificial ſines and tangents.

The

The APPENDIX, will shew how all kinds of sailling, or the whole art of Navigation is performed, without either books, tables, or instruments whatever, but by the pen or peneil only.

To conclude. Therefore, if this fruit of my labour find good acceptance in the world, I shall then think my pains well bestowed; and thus desiring a favourable construction to be put upon what faults or errors may escape either the pen or the press, I doubt not the Noble-hearted Sailors acceptance; and that it may be a benefit to the Buyer, a help to the Learner, a fit companion to the Mariner, and a credit to the Author, is the humble and sincere desire, of

Yours,

Whitehaven, With the highest Respect

March 28. 1774. To serve you.

WILLIAM CHAMBERS.

THE

THE

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——— Richard Robinſon
——— Henry Robinſon
——— Thomas Rudd
——— John Rookin

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Rev. Thomas Spedding
Mr James Spedding
Mr, Iſaac Stephenſon
Mr. Robert Sanderſon
Mr, Joſeph Simpſon
Mr, Edward Steel
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Mr. James Souter
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Mr. William Smith
Mr, Richard Sherwin
Mr, Samuel Sandick
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Mr. Japheth Singleton
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Mr. John Swainſon
Mr. John Souter
Mr. John Smith
Mr. Henry Salkeld
Mr Joſhua Studholme
Rev. Joſhua Sedgwick
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Mr. George Sloan
Mr. William Shanks
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Mr. James Scoret
Mr, John Smith
Mr. Matthias Shepherd
Captain Michael Sherky
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——— William Stewart
——— William Sharp
——— Joſeph Steel
——— John Smith
——— John Sowerby
——— John Storey
——— Deaker Stobridge
——— Anthony Smith
——— Henry Spence
——— James Stewart
——— John Stobo

T

Peter Taylor Eſq,
Mr. Fawt. Troughton merch.
Mr. John Thwaite
Mr. Joſeph Tiefdal
Mr, John Turner,
Mr. Jackſon Todd
Mr. John Tyſon
Mr. Richard Tyſon
Mr. Henry Townſon

Henry

T

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Mr, William Trourey
Capt, Richard Todd
——James Thompſon
——Henry Tindall
——Henry Thomſon
——Francis Teiſer
——Jacob Topping
——Joſeph Todhunter
—— James Thompſon

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Mr, Iſaac Williamſon
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Capt. Chriſtopher Williamſon
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Mr, Daniel Watſon
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Mr, Joſeph Wells
Mr, James Wilſon
Mr, William Weſtray
Mr, Robert Wilkinſon
Mr, William Williamſon
Mr, William Tyſon Walker
Mr, John Wilkinſon

W

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Mrs, Sarah Wray
Mr, William Wright
Mr, John Wilſon
Mr, Thomas Welch
Captain William Wood
———Joſeph Watſon
——— John Williamſon jun,
———Chriſtop. Williamſon
———Joſeph Wabby
———John Wilſon
———James Welſh
———Joſeph Weſtray
———Joſeph Wilſon
———Joſeph Wiley
———William Walker
———Richard White
———John Walker
———Thomas Walſh

Y

Capt. William Younghuſband
——Joſeph Younghuſband
——Francis Younghuſband
——John Yowart jun.
——Francis Yowart jun.
Mr. John Youdell
Mr. Joſeph Younghuſband

In *Workington* and its *Environs*.

A

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B

Capt. John Bell, Seaton

B

Capt. John Beeby
Capt. William Bornowdale

C

Henry Curwen Eſq. 4 Copies
Capt. John Courſe

Bowman

C

Capt, Bowman Croſthwait
—— William Cragg
——Matthew Capeg
——Chriſtopher Cragg

D

Capt. John Davis
——William Dixon

E

Mr, Thomas Elliſon
Mr, John Elwood

F

Capt. William Falcon
—— William Fiſher
Mr, John Falcon
Mr. Caleb Grave, Flimby

G

Capt. John Griffin

H

Capt. Thomas Hayſton
——Joſeph Hayton
——John Hudſon
——Joſeph Harriſon
——Joſeph Hargrove
——Joſeph Head
——John Hargrove
Mr. Philip Hall, march.
Mr. John Harriman
Mr. John Hodgſon

I

Capt. Thomas Jackſon
——William Jackſon
Mr, Jonathan Jackſon

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L

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M

Capt. Robert Martindale
——Thomas Martindale
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Mr. Joſeph Maſhal, Seaton

NOP

Capt. Fletcher Peel
——Thomas Patinſon
Mr. John Peirce

QR

Mr. John Robinſon
Mr, —— Rumley

S

Capt, John Scott
—— Henry Seekel
——Thomas Smith
——Joſeph Stockdale
——John Steel
Mr. William Stevens
Mr, John Smith
Mr, George Sugdale
Mr. Edward Smith
Mr, John Sim

TW

Capt. William Tully
——Jonathon Tickel
Capt, William Wilſon
Mr. John Wood
Mr. William Watts
Capt, Muſgrove Walker
Mr, John Wilkes

In *Mary Port* and its *Environs*.

Mr. John Scott
Capt John Messenger
Mr. John Litler
Mr. John Fletcher
Capt. Edward Seller
Mr, Joseph Robinson
Capt. Joseph Pattinson
—— Richard Fletcher
—— William Pearson
Capt. William Harris
Mr. Jonathan Thompson
Mr. William Parker
Capt. Daniel Dickioson
Mr, John Fearon
Mr. Joseph Paitson
Mr. Samuel Shannon
Capt. William Lonsdale
—— John Gibson
Mr. John Fletcher
Mr. Joseph Hutchinson
Mr. William Wood
Mr. Thomas Faucet
Mr. Joseph Younghusband

ERRATA, Page 30 line 17, for Lat, 32 ,25 W, Read Latitude 32 .25 N,

THE

THE
UNIVERSAL NAVIGATOR:
OR,
A COMPREHENSIVE TREATISE OF
NAVIGATION.

Geometrical Problems.

A PROBLEM, is a propoſition which requireth ſomething to be done, as to make ſome figure, to add or ſubtract one figure to or from another; to make a circle paſs through any three given points not lying in a right line, &c.

PROBLEM I. *Pl.* I. *Fig.* 1.

To Divide a given Line A. B. *into two equal Parts.*

First. Set one foot of your compaſſes in the point A, and opening the other foot to any convenient diſtance above half the length of the line A. B. make the arches D and G, above and below the line.

Second. With the ſame extent, ſet one foot in B. and croſs theſe arches in E. and F.

Third. Draw the line E. G. which will divide the line A. B. into two equal parts in C as was required.

PROBLEM II. *Pl.* I. *Fig.* 2.

Upon a point in a Line given, to erect a Perpendicular.

Let A. B. be the given line and let C be the point aſſigned therein, on which it is required to erect the perpendicular G. C.

First. Set one foot of the compaſſes in the point C, and open the other to any convenient diſtance as to D. and make the points D. and E. of equal diſtance from C

Second. Set one foot in D and open the other at pleaſure, and deſcribe the arch F, and with the ſame extent of the compaſſes, with one

foot in E. croſs the former arch in C. draw the line C. G. which will be perpendicular to A. B. upon the point C. as was required.

PROBLEM III. *Pl.* I. *Fig.* 3

To erect a Perpendicular, on the end of a given Line.

Let A. B. be a given line, and from the point A. at the end thereof let it be required to erect a perpendicular B. C.

I. Open your compaſſes to any diſtance at diſcretion, and ſet ing one foot in the given point A. deſcribe the arch F E D then ſet one foot in D. (the compaſſes being at the ſame diſtance, croſs the ſaid arch in E. and ſetting one foot in E. with the other deſcribe the arch A. F. G. croſſing the firſt arch in F. then ſet one foot in F with the other deſcribe the arch H. H. croſſing the former in C.

II. Draw the line A. C. which will be perpendicular to the line A. B. as was required.

PROBLEM. IV.

From a given Point P. to let fall a Perpendicular to a given Line.

In this there are two caſes, firſt, when the given point is over or near the middle of the line, ſecondly when it is near or almoſt over the end of the line.

Let N. O. be a right line given and from the point P. over it, let it be required to let fall the perpendicular P. Q.

I. Open your compaſſes to any diſtance greater than P. Q. ſetting one foot in the point P with the other deſcribe the arch of a circle, cutting the given line N. O. in the points R. and S.

II. Divide the line R. S. into two equal parts in Q. (by prob. I.) ſo a line drawn from the point P. to Q. ſhall be perpendicular to the given line N O.

PROBLEM. V. *Pl.* I. *Fig.* 5.

To draw a Line Parallel to a given Line.

Let A. B. be a line given unto which it is required to draw a parallel.

I. Set one foot in the end A. and with any extent required make the arch E.

II. With the ſame extent of your compaſſes, ſet one foot in the other end B. and deſcribe the arch D.

III. Lay your ruler to the top of theſe two arches, ſo that it does not croſs, but juſt touch them, then by the ſide thereof draw the line N O which will be the parallel required.

PROBLEM VI. *Pl* I. *Fig.* 6.

To make an Angle as D. B. C. *equal to a given Angle* x y z.

From the point Y. with any radius, deſcribe an arch as M. N. and from the point B. with the ſame radius, deſcribe the arch B D then take

take the length of the arch M. N. in your compaſſes, and lay it on the other arch from B. to d. and from the point D. through the points B. and D draw the lines B. D. and B. C. and the angle B. D. C. is equal to the given angle X. Y. Z. as was required.

PROBLEM. VII. *Pl.* I. *Fig.* 7.

From a given Point A. *to make an Acute Angle, of* 41deg. 15m. *is required.*

I. From the ſcale of chords, take the chord of 60 degrees, and with that radius and one foot of the compaſſes in the point A. deſcribe an arch as X. Y.

II. From the line of chords take 47d. 15m. and lay it on the arch, point X. to Y. and from the point A. through X. and Y. draw out the lines A. B. and A. C. and the angle B. A. C. is the angle required.

PROBLEM. VIII. *Pl.* I. *Fig* 3

From the line of Chords, to make a Right Angle, or an Angle of 90 deg. *is required.*

I. With the chord of 60 deg. from the point X. deſcribe an arch as A. B. take the chord of 90deg. and lay it on the arch from A. to B

II. From the center X. through A. and B. draw the lines X. C. and X. D. and the angle D. X. C. will be a right angle.

PROBLEM. IX. *Pl.* I. *Fig.* 9

From a given Point A. *to make an Obtuſe Angle of* 134 deg. 54m. *is required*

With the chord of 60 degrees from the point A. deſcribe an arch, as X. Y. from the chords take 67 37 = half of the given angle, and lay it on the arch from X. to Z. and from Z. to Y.

II. Through X. and Y. draw out the lines A. X. and A. Y. and the angle x. A. y. will be equal to 134 deg. 54m. as required.

PROBLEM X. *Pl.* I. *Fig.* 10.

To Biſect or Divide a right Lined Angle into two equal Parts.

Upon the angular point C. with any convenient radius, deſcribe an arch, as x. y. from theſe points x y deſcribe equal arches, croſſing each other in D. join the points C, and D. with a right line, and it will biſect the arch x. y. and conſequently divide the angle into two equal parts as was required.

PROBLEM. XI. *Pl.* I. *Fig.* 11.

Upon a right line given as A. B *to deſcribe an equilateral Triangle is required.*

I. Make the given line A. B. radius and with it upon each extreme

points or ends at A. and B. deſcribe equal arches, viz. A. C. and B. C.

II. Join the points A. C. and B. C. with right lines and they will make the triangle required.

PROBLEM. XII. *Pl.* I. *Fig.* 12.

Three right Lines being given to form them into a Triangle, provided any two of them taken together, be longer than the Third.

I. Make either of the ſhorter lines radius, as the line C. and upon either end of the longeſt line as at A. draw the arch C c then take the extent of the line B. in the compaſſes, and with one foot in B. deſcribe another arch, to croſs the firſt arch in C. then join the points C. A. and C. B. with right lines, and they will make the triangle required.

PROBLEM. XIII. *Pl.* I. *Fig.* 13.

To divide a right Line, given into any number of equal Parts.

I. Let A. B. be a right line given, to be divided into ſeven equal parts.

II. From one end of the given line A. B. draw the line A. C. making an angle therewith at pleaſure, and draw the line B. D. making the ∠ B = the ∠ A. then ſet off upon theſe two lines any number of equal parts, leſs by one then the parts into which the line A. B. is to be divided, which in this example muſt be 6 then draw ſmall pricked lines from 1 to 6, which lines croſſing the given line A B will divide the ſaid line into 7 equal parts as required.

PROBLEM XIV. *Pl.* I. *Fig.* 14.

Upon a given right Line, as A. B. *to make a Geometrical Square.*

I. Upon one end of the given line A. B. erect the perpendicular A. C. [by Prob. III] equal in length with the given line A B.

II. Make the given line radius, and upon the points B. and C. deſcribe the Arches to croſs each other in C. join the points C. D. and B. D. with right lines, which will form the ſquare required.

PROBLEM XV. *Pl.* I. *Fig.* 15.

Two unequal right Lines, as A. B. *and* B. C *being given to make a Right angled Parallelogram.*

I. Upon the end of the longeſt line as at A. erect the perpendicular A. B. the length of the ſhorteſt line B. C

II. Make the longeſt line radius, and one foot of the compaſſes in A. deſcribe an arch with the ſame extent, and one foot in B. deſcribe another arch, which will cut the former in D. then join the points C. D. and B. D. with right lines, which will make the parallelogram required.

PROB-

PROBLEM XVI. *Pl.* I. *Fig.* 16.

To describe a Circle through any three Points not situate in a right Line.

I. Join the points B. A. and B. C. with right lines, divide the lines A.B. and B.C. each into two equal parts, and draw the bisecting lines X. O and y o which will intersect each other in O. which point O will be the center of a circle that will pass through the three points A. B. and C. as required.

An Explanation of the Notes, Signs, or Characters, that are used in this Work.

+	Stands for sign of	Addition
−		Less, in Subtraction
×		Multiplication
÷		Division
∴		Disjunct Proportion
∺		Continual Proportion
∴	Stands for	Ergo, or therefore
⊐		Greater than
⊏		Lesser than
=		Equal to
$\sqrt{}$		Square Root
$\sqrt[3]{}$		Cube Root
∠		An Angle
∟		A Right Angle
△		A Triangle

MENSURATION.

MEASURING of superficial figures shews both arithmetically and instrumentally how to measure any kind of plain superficies, as Flat, Stone, Board, Glass, Wainscot, Plaistering, Painting, Paving, &c.

PROBLEM. I. *Pl.* I. *Fig.* 17.

The Length and Breadth, of any Square or Long Square Superficies, given to find the Superficial Content in Foot Measure.

THE GENERAL RULE. Multiply the length by the breadth when they are both in inches and divide the product by 144 the quotient arising gives the content in feet, and the remainder divided by 12 gives inches and parts; or multiply the length by the breadth (when

(when they are both in foot meaſure) and the product gives the content in feet.

Example. Suppoſe a plank be 13 inches broad, and 17 feet 10 inches long, I deſire to know how many ſuperficial feet is contained in the plank.

17 feet 10 inches = 215 then $214 \times 13 = 2782$

And $\frac{2782}{144} = 29$ feet 3 inches 10 parts, the ſuperficial content in feet required.

By the Sliding Rule.

Set 12 on the ſliding piece, to 13 on the fixed line, then againſt 17 feet on the ſliding piece is found 19 33 feet on the fixed line the anſwer.

Example II. If a plank be 2 feet 8 inches broad and 29 feet 11 inches long, required how many ſuperficial feet is contained in that plank.

By Decimals, $.29.916 \times 2.6666 = 79.757$ the ſuperficial content in feet.

By the Sliding Rule.

Set 1 on the ſliding piece, to 2.666 on the fixed line, then againſt 19 916 on the ſliding piece you will have 79.75 &c. on the fixed line the anſwer required.

A Table of inches in Decimals

Inches	Deci.
11	.9166
10	.8333
9	.75
8	.6666
7	.5833
6	.5
5	.4166
4	.3333
3	.25
2	.1666
1	.0833

PROBLEM II. *Pl.* I. *Fig* 18.

To meaſure a Rhombus.

A Rhombus is a figure repreſenting a Quarry of Glaſs, having four equal ſides, and four angles, two of them being obtuſe, and two acute as the figure repreſents.

It is demonſtrated by the 35 propoſition of the firſt book of Euclid, that parallelograms having the ſame baſe, and being between the ſame parallels, are equal, that is the parallelogram here annexed, is equal to the rhombus, A B C D. Rule, multiply the length by the perpendicular, and the product is the area.

Example. Suppoſe there be a piece of marble pavement repreſenting the figure of a rhombus, each ſide thereof being 18 feet 11 inches, and a perpendicular B E be let fall from the obtuſe angle upon one of its ſides, = 13 feet 8 inches, required how many ſuperficial feet is contained therein.

Arith-

Arithmetically by croſs multiplication.

Multiply	18 . 11
By	13 . 8
	54
	18
	12 . 0 . 0
	11 . 11 . 0
	7 . 4
Content in feet	258 . 6 . $\frac{1}{2}$

Inſtrumentally, By the Sliding Rule.

Set 1 on the ſliding piece, to 13. 66 on the fixed line, then againſt 18. 916, on the ſliding piece you will have 258 51. on the fixed line, the anſwer required.

PROBLEM III. *Pl.* I. *Fig.* 19.

To meaſure a Rhomboides.

A Rhomboides is a figure having four ſides, the oppoſite ſides thereof being equal and parallel, and alſo four angles, the oppoſite whereof are equal to find the content thereof, this is the general rule.

Multiply one of the longer ſides, by the perpendicular let fall from one of the obtuſe angles, to its oppoſite ſide, and the product is the area, or ſuperficial content, in the ſame kind of meaſure, that your dimenſions are in.

Suppoſe there be a piece of wainſcot in form of a rhomboid, whoſe longeſt ſide is 15 feet .10 inches and the perpendicular let fall from the obtuſe angle is 9 feet 11 inches, I deſire to know the ſuperficial content thereof in feet and yards.

Here $\frac{15\ 83 \times 9\ .916}{9} = \frac{157}{9} = 17$ yards 4 feet.

By the Sliding Rule.

Set 1 on the ſliding piece to 9 .916 on the fixed line, then againſt 15 .83 on the ſliding piece, you will have 156 98, on the fixed line the ſuperficial content in feet, which divided by 9. quotes 17 .44 the content in yards.

PROBLEM IV. *Pl.* I. *Fig.* 20.

To meaſure a Triangle.

A triangle is a figure having three ſides, and three angles; triangles are either right angled or oblique angled, right angled triangles are ſuch as have one right angle, oblique angled triangles, are ſuch as have their angles either acute or obtuſe, an obtuſe angle is greater than a right angle, that is, it is more than 90 deg. and an acute angle is leſs than 90 deg. to find the ſuperficial content, this is the general rule.

Let

Let the triangle be of what kind ſoever, multiply the baſe by half the perpendicular or half the baſe by the whole perpendicular, and take half the product; either of the ſe two ways will give the content required, in the ſame kind the dimenſions are taken, or half the product of the baſe and perpendicular gives the area.

Example. Suppoſe there be a piece of marble pavement in form of a right angled triangle, whoſe baſe is 21 7 feet, and perpendicular 12 .8 feet, how many yards is contained therein.

Then $\frac{21.7 \times 12.3}{2}$. = 138 .88 The Anſwer in Feet.

And $\frac{138.88}{9}$ = 15.43 the content in yards Q E I.

PROBLEM V. *Pl.* I. *Fig.* 21.

To meaſure a Trapezium.

A Trapezium, is a figure containing four unequal ſides, and four oblique angles, to find the area or ſuperficial content thereof obſerve the following rule.

Multiply the half ſum of the two perpendiculars by the diagonal, or multiply the whole ſum by half the diagonal, and the product is the area of the two triangles, A B C and A D C, is the area of the trapezium required.

Example. Suppoſe there be a piece of ground in the form of a trapezium, whoſe longeſt diagonal is 35 .5 perches, the perpendicular B E = 16 .8 perches, and the perpedicular D E = 16 .7 perches, required the area or ſuperficial content thereof in acres.

Then $\frac{16.8 + 16.7 \times 35.5}{40 \times 4 \times 2}$ = three acres one rood, 35 .125 perches, the contents required.

PROBLEM VI.

To Meaſure a Polygon.

Regular polygons, are ſuch figures as have more than four ſides; all the ſides and angles thereof being equal polygons, are denominated from the number of their ſides and angles.

If the figure conſiſts of	5	Equal ſides and angles; It is called a regular.	Pentagon
	6		Hexagon
	7		Heptagon
	8		Octogan
	9		Eneagon
	10		Decagon
	11		Endecagon
	12		Dodecagon

To

To find the area or ſuperficial content of any regular polygon, this is the general rule, Multiply the whole perimeter, or ſum of the ſides, by the perpendicular, let fall from the center of the polygon upon the middle of one of its ſides, and the product is the area, or multiply half the perimeter by the whole perpendicular.

Example. If a flower garden be in form of a regular hexagon or a polygon conſiſting of ſix equal ſides, each ſide being 18 .7 yards and the perpendicular let fall upon one ſide is 21 .4 yards, required the ſuperficial content in yards.

Then 18 .7 × 3 = 56 1 the perimeter or half 6 ſides. And 56.1 × 21.4 = 1203 54 = area in yards.

PROBLEM VII. *Pl.* I. *Fig.* 23.

To Meaſure a Circle.

A circle is a plain figure contained under one line, which is called a circumference, unto which all lines drawn from a point in the middle of the figure, called the center, and falling upon the circumference thereof are all equal to each other; the circle contains more than any plain figure of equal compaſs.

THE RULE. Every circle is equal to a parallelogram, whoſe length is equal to half the circumference, and the breadth equal to half the diameter, then multiply half the circumference by half the diameter, and the product is the area of the circle.

Example. If the diameter be 19 3 feet, and the circumference = 60 63288 feet, required the ſuperficial contents in feet.

	F. P.
half circum.	30 31
half diam.	9 65

Then 30 .31644 × 9.65 = 292 .553646, the area, or ſuperficial content requred; Or if you multiply the ſquare of the diameter by .7854, and the product is the area; that is 19 .3 × 19 .3 × .7854 = 292 5536 = the area, the ſame as before.

PROBLEM III. *Pl.* I. *Fig.* 24.

To Meaſure an Elipſis or an Oval.

An Elipſis is a figure bounded by a regular curve line turning into itſelf but of its two diameters, cuting each other in the center, one is longer than the other, in which it differs from the circle.

THE GENERAL RULE. Multiply the tranſverſe diameter by the conjugate, and that product multiply by .7854, this laſt product is the area of the elipſis required.

Example. Suppoſe there be a table in form of an ellipſis, whoſe tranſverſe diameter is 58.5 inches and conjugate 44.7 inches, required the ſuperficial content in feet.

Then $\frac{58.5 \times 44.7 \times .7854}{144} = 14.262\ 37$ feet, the Anſwer required.

MEASURING *of* SOLIDS.

Solid bodies are ſuch as conſiſts of length, breadth, and thickneſs; as ſtone, timber, globes, bullets, &c.

PROBLEM I. *Pl.* I. *Fig.* 25.

To Meaſure a Cube.

A cube is a ſquare ſolid, comprehended under ſix geometrical foures, being in form of a die; to find the ſolid content thereof obſerve this general rule.

Multiply the ſide of the cube into itſelf, and the product again by its ſide, the laſt product will be the ſolid content of the cube, which if in inches, divide by 1728, the quotient will be the ſolid content in feet.

Example. If the ſide of a cube be 29.5 inches, I demand how many ſolid feet this cube contains.

Then $\frac{29.5 \times 29.5 \times 29.5}{1728} = 14\ 856$ feet, the anſwer.

PROBLEM II. *Pl.* I. *Fig.* 26.

To Meaſure a Parallelopipedon.

THE GENERAL RULE. Multiply the ſide of the baſe in inches into itſelf, and that product by the length in feet, and divide the product by 144, quotes the content in ſolid feet, or if the length be given in inches you muſt divide the product by 1728, gives the ſolid content in feet.

Example. Let the figure A B C D E F G, be a parallelopipedon, or ſquare priſm, repreſenting a ſquare piece of timber, each ſide of its baſe 14.9 inches, and length 17 feet nine inches, required the ſolid content in feet, arithmetically and inſtrumentally.

Arithmetically $\frac{14 \times 14 \times 17.75}{144}$ = 24.16 to the ſolid contents in feet, the Anſwer required.

Inſtrumentally by the ſliding rule. Set 12 on the girt line to 17.75. the length on the ſliding piece, then againſt 14 on the girt line you have 24.16 on the ſliding piece, the Anſwer.

Example.

Example 2d. If a piece of timbe be 17 inches ſquare, and 21.6 feet long, required how many ſolid feet it contains.

Arithmetically, $\frac{17 \times 17 \times 21.6}{144} = 43\ 3$ feet the ſolid content requir d.

PROBLEM. XI. *Pl.* I. *Fig.* 27.

To Meaſure a Triangular Priſm.

A priſm is a ſolid, contained under ſeveral planes, and having its baſes alike, equal and parallel, the ſolid content of a priſm (whether triangular or multangular) is found by multiplying the area of the baſe into its length or height, and the product is the ſolid content thereof.

Example. Let the figure A B C D repreſent a triangular priſm, each ſide of the baſe being 15. 6 inches, and the length of the ſolid 19 feet 6 inches, required the ſolid content thereof in feet.

Arithmetically. $\sqrt{15\ 6^2 - \frac{15\ 6^2}{4}} = 13\ 5 =$ the perpendicular of the triangular baſe; then $\frac{19\ 5 \times 13.5}{2 \times 144} = 14.25$, hence the ſolidity in feet, is 14 feet and one quarter, as was required.

Inſtrumentally. Set 13 5 on the ſlider to 13 5 on the girt line, then againſt 7.8 on the ſliding piece you have 10 .26 on the girt line, then ſet 12 on the girt line, to 19.5 the length on the ſliding piece, then againſt 10 26 on the girt line, you will have 14.25 on the ſlider, the content in feet required.

Example 2d. Suppoſe the figure A B C D E F G H I K, to repreſent a priſm, whoſe baſes are regular hexagons, or a piece of timber ſquared into ſix equal ſides, each ſide of the baſe 14 inches, and the perpendicular let fall from the center of the polygon upon the middle of one of its ſides is 12 .1 inches, alſo the length thereof is 19 feet 11 inches, required the ſolid content of the priſm in feet?

Arithmetically. $14 \times 3 = 42 =$ half ſum of the ſides, Then $\frac{42 \times 12.91 \times 19\ 916}{144} = 75,\ 2927 =$ ſolid content in feet, as was required.

Inſtrumentally by the ſliding rule. Set 12 on the ſliding piece to 12 on the girt line, then againſt 42 on the ſliding piece, you will have 22.54 on the girt line, the ſide of a mean ſquare priſm; then ſet 12 on the girt line to 19.916 the length on the ſliding piece, then againſt 22 .54 on the girt line you will have 75 .29 on the ſliding piece, the content in feet, the ſame as before.

PROBLEM IV. *Pl.* I. *Fig.* 29.

To Meaſure a Square Pyramid.

A Pyramid is a ſolid figure, whoſe baſe is a polygon, and the ſides are iſoſceles triangles, their ſeveral tops meet together in one point, to find the ſolid content thereof, this is the general rule. Multiply the area of the baſe by one third of the altitude or length, and the product is the ſolid content of the pyramid.

Example. Let the figure A B C D, repreſent a ſquare pyramid whoſe ſide of its baſe is 19 inches, and its perpendicular height E D is 21 feet 9 inches, required the ſolid content of the pyramid in feet?

Arithmetically. $\frac{19 \times 19 \times 21\ 75}{144 \times 3} = 18.17$ feet, the ſolidity of the pyramid required.

Inſtrumentally by the ſliding rule. Set 12 on the girt line to 7 25 (one third part of the altitude) on the ſliding piece, then againſt 19 (the ſide of the baſe) on the girt line, you will have 18.17 on the ſliding piece, the content in feet; the ſame as before.

Example 2d. Let the figure A B C D E F be a pyramid, whoſe baſe is a regular pentagon, each ſide thereof being 23.4 inches, and the perpendicular let fall from the center of the polygon upon the middle of one of its ſides is 10.1 inches, and its perpendicular altitude = 21 feet 10 inches, required the ſolid content in feet.

Arithmetically. $23\ 4 \times 2.5 = 58.5$ half the ſum of the ſides, and $10.1 \times 58\ 5 = 942\ 0606 =$ the area of the baſe, and $\times \frac{22.83}{3 \times 144} = 47.6$ feet, the ſolid content in feet.

Inſtrumentally. Find a mean proportional between the perpendicular and half the ſum of the ſides which will be 35.7, then ſet 12 on the girt line to 7.27 (one third the altitude) on the ſliding piece, then againſt 35.7 on the girt line you have 47.6 on the ſliding piece, the content required.

PROBLEM. V. *Pl.* I. *Fig.* 31.

To meaſure a Cylinder.

A cylinder is a round ſolid, having its baſes circular, equal, and parallel in form of a rolling ſtone, uſed in a garden; to find the ſolidity thereof, this is the general Rule.

Multiply the area of the baſe by the length, and the product is the ſolid content thereof, in the ſame denomination your dimenſions are taken in.

Example.

Example. Let the figure A B C D, repreſent a cylinder, whoſe diameter A B, is 28 .7 inches, and the length = 16 feet 11 inches, required the ſolid content in feet?

Arithmetically. $28.7 \times 28.7 \times .7854 = 646.92612$, the area of the baſe; and $\frac{646\ 966 \times 16.916}{144} = 75.9958$, or 76 the ſolidity in feet as was required.

Inſtrumentally. Set 13.53 on the girt line, to 16.916 on the ſliding piece, then againſt 28.7, on the girt line you will have 76 on the ſlider, the content in feet.

PROBLEM VI. *Pl.* I. *Fig.* 32.

To Meaſure a Cone.

A cone is a ſolid, having a circular baſe, and growing ſmaller and ſmaller till it ends in a point called the vertex, and may be nearly repreſented by a ſugar-loaf; to find the ſolid content thereof, multiply the area of the baſe by one third part of the perpendicular height, and the product is the ſolid content.

Example. Suppoſe the figure A B C D to repreſent a cone whoſe diameter of its baſe is 21. 8 inches. and its perpendicular height C D, is 19 feet 10 inches, required the content in feet.

Arithmetically $21.8 \times 21.8 \times .7854 = 373.253$ the area of its baſe, and $373.253 \times 6.61 \div 144 = 17.133$ the ſolidity in feet required.

Inſtrumentally, Set 13.53 on the girt line to 6.61 on the ſlider (one third of altitude) then againſt 21.8 on the girt line you will have 17.13 on the ſlider the content in feet as before.

PROBLEM VI.

To meaſure the Fruſtum of a Pyramid.

A fruſtum of a pyramid is the part remaining after the top is cut off by a plain parallel to its baſe, to find the content thereof, there are ſeveral rules, but I ſhall here uſe that which is moſt eaſy and applicable to working by the ſliding rule.

To the product of the ſides of the two baſes, add one third part of the ſquare of their difference, that ſum multiplied by the height will produce the ſolidity, if the baſes be ſquare, but if they be triangular or multangular, the ſaid products of the ſides, with the third part of the ſquare, if their difference will be the ſquare of a mean ſide, and the ſquare root thereof will be ſuch a mean ſide as will reduce the tapering ſolid to a ſquare priſm, equal in ſolidity thereunto.

Example. Suppoſe the figure A B C D, to repreſent the fruſtum of a ſquare pyramid the ſide of the greater baſe is 27. 5 inches, and the

the ſide of leſſer baſe is 11.9 inches, and the height is 22.9 feet required the ſolidity of the fruſtum in feet.

Arithmetically.

$$\frac{27.5 \times 11.9 + \frac{27.5 - 11.9^2}{3} \times 22.9}{144}$$

= 64 942 = the ſolid content in feet as was required.

The ſquare root of the product of the area of the two baſes, when the third part of the ſquare of their difference is firſt added, will be a ſide of a ſquare priſm, equal in ſolidity to the fruſtum, then ſet 12 on the fixed line, to 22 9 length in the ſliding piece, then againſt 20.2 the ſide of a mean ſquare priſm, on the girth line you have 64 9 as before.

To meaſure the Fruſtum of a Cone.

A fruſtum of a Cone is that part which remains when the top end is cut off, by a plain, parallel to the baſe, to find the ſolid content thereof the rule is the ſame in effect, as for the fruſtum of a pyramid.

To the product of the greater and leſſer diameters, add one third part of the ſquare of their difference, and multiply the ſum by .7854 and the product is a mean area, which multiplied by the perpendicular height, the product is the ſolidity of the fruſtum cone, as required.

Example. Suppoſe the figure A B C D be the fruſtum of a cone, or otherwiſe a round piece of tapering timber, whoſe greater diameter C D is 24 9 inches, and the leſſer diameter A B is 9.7 inches, and the perpendicular height is 21.75 feet, required the ſolid content thereof in feet?

Arithmetically. $\frac{24.9 \times 9.7 + \frac{24.9 - 9.7^2}{3} \times .7854 \times 21.75,}{144} =$

37 .78 the ſolid content of the fruſtum in feet.

Of TUNNAGE.

This being neceſſary to a mariner, that he may underſtand how to meaſure or give the tunnage of ſuch goods as may be ſent on board his ſhip; I ſhall therefore give him ſome plain directions on this head, only obſerving that 40 ſolid feet is to be accounted for a tun.

A GENERAL RULE. Multiply the length, breadth, and depth together it gives the content in ſolid feet, which divide by 40 gives tuns.

Example. I. If a caſe be 5 feet long, 4 feet broad, and 3 feet deep, required the tunnage.

$\frac{5 \times 4 \times 2}{40} = \frac{60}{40} =$ 1 tun 20 feet, the tunnage required.

Example, II. Again a parcel of houſe hold goods, piled together is found to be 10 feet long, 5 feet broad, and 4 deep, required the tunnage.

$\frac{10 \times 5 \times 4}{40} = \frac{200}{40} = 5$ tuns the anſwer required

Note. If any of the dimenſions have inches in them, let all the dimenſions be reduced into inches, and the ſolid content muſt be divided by 1728 by reaſon that a ſolid foot contains ſo many inches.

Example, III. If a bale be 4 feet 6 inches long, 3 feet broad, and 2 feet deep, required her tunnage?

F. I. F. F. I. I.

$4 - 6 = 54$ $3 = 36$ $2 = 24$ $\frac{54 \times 36 \times 24}{1728} = \frac{46656}{1728} = 27$ feet the anſwered required,

Example IV. A box 3 feet 6 inches long, 3 feet broad, and 2 feet 7 inches deep, I demand the tunnage?

F. F. I.

3 F. 6 In $= 42$ $3 = 36$. $2.7 = 31$. Then $\frac{42 \times 36 \times 31}{1728} = 27\ \frac{1296}{1728}$ feet, = the content in feet.

If the ends of the bales or caſes be not alike, add the dimenſions of the ends together and take the half thereof.

Example V A caſe 4 feet long at one end, and 5 feet deep at the other end, 3 feet ſquare: required the tunnage?

One end 5
Other end 3
8
mean end 4

$\frac{5 \times 4 \times 9}{40} = \frac{144}{40} = 3$ Tuns 24 Feet; The Tunage required.

Example 6 A caſe 10 feet long one end 3 feet 6 inches broad, and 2 feet 10 inches deep, the other end 2 feet 8 inches broad and 1 foot 10 inches deep, required the tunnage?

	F.	I.	F.	I.	F.
One end	3	6	2	8	10 = 120
	2	10	1	10	3 2 38
	6	4	4	6	2 3 27
	3	2	2	3	

rod

$\frac{120 \times 38 \times 27}{1728} = \frac{123120}{1728} = 71.\frac{432}{1728}$ and $\frac{71}{40} = 1$ tun $.31\frac{.432}{1728}$ feet: the tunnage.

Example VII. If a round caſe be 5 feet 7 inches long, the diameter at one end, being 11 feet 4 inches at the other end 3 F. 8 In. I deſire to know what is the tunnage?

One end	4	4	5.7=67 4 0=48 then will $\frac{48 \times 48 \times 67}{12 \times 12 \times 12}$
Other end	3	8	
	8	0	.8) $\frac{586}{1728}$ and $\frac{89}{40}$ = 2 tuns $\frac{9.586}{1728}$ feet; The
M. D.	4	0	Tunage required.

If it be objected that round caſes thus tunnaged gives too much, I anſwer they take up ſo much room in the hold. But if you are inclined to comply with thoſe objectors, you are to conſider that the proportion between a ſquare and a circle, whoſe ſide and diameter are equal, is as 14 to 11, therefore multiply the content taken as before by 11, and divide the product by 14 it will produce the tunnage, and anſwer the objection.

The content of the foregoing caſe 89 feet then ſay,

$\frac{89 \times 11}{14} = 69.$ and $\div 40. = 1$ tun and 29 feet

Ships are meaſured by the length of their keel, breadth of the midſhip beam, and depth of their hold, and 95 ſolid feet are uſually accounted for a tun.

Example. 1ſt Suppoſe a ſhip 59 feet by the keel, 21 feet by the beam, and 11 feet in the hold, required what is her tunnage?

Solution $\frac{59 \times 21 \times 11}{95} = \frac{13629}{95} = 143$ tuns $\frac{44}{95}$ the tunnage required.

Example. 2. Suppoſe there be a ſhip, 95 feet by the keel, 30 feet 8 inches by the beam, and 17 feet in the hold, required her tunnage.

Solution. 95 feet = 1140 inches 30.8 = 368 17 = 204, then $\frac{1140 \times 368 \times 204}{1728 \times 95} = 521$ Tuns one quarter, the tunnage required.

PLAIN TRIGONOMETRY.

TRIGONOMETRY is the meaſuring of a triangle having three things given, either ſides or angles, or both a fourth ſide or

or angle may be found, whether plain or superficial, but plain trigonometry we begin with first.

This Diagram represents all the lines on the Plain Scale. Pl. II. Fig. 35.

Now since these lines are frequently put upon scales, &c. divided either by a line of equal parts, and the tables of sines, tangents, and secants, &c. or a circle actually divided into 360 degrees, by the directions following.

To make the Line of Longitudes A N.

Divide the line W B, into six equal parts, 1, 2, 3, 4, 5, 6, B. and from each point let fall a perpendicular until it meets the quadrant A B, then place one foot of your compasses in the point A, and with the other transfer the points where these perpendiculars intersect the arch to the line A N, so will you divide it into its primary parts, but for the minutes you must divide each sixth part of the line W B, into ten other equal parts, and then transfer them to A N, as you did the primary divisions.

To make the Line of Rhombs A B.

Divide the quadrant A B into eight equal parts, (four is enough) then set one foot of your compasses in the point A, and with the other transfer those divisions from the quadrant to the line A B, and set figures to it as in the Diagram.

To make the line of half Tangents, C H.

Lay a ruler upon the point A, and over every degree of the quadrant B E, and where it intersects the line C H make a mark agreeable to these in the arch or quadrant, and it is done.

To make the Line of Chords B E.

Divide the quadrant B E, into 90 equal parts, then setting one foot of the compasses in the point E, transfer the divisions to the line B E.

To make the Line of Tangents E F.

Lay a ruler upon the center C, and upon every degree of the arch B E, and where it intersects the line E F make marks, and set figures to them, as in the scheme.

To make the Line of Secants E F.

Set one of the compasses in the center at C, and extend the other to each degree of the tangent line, which transfer to the line C F, and figure it with the same figures that the tangent line is marked with.

To make the Line of Sines C D.

Divide the quadrant D E, into ninty equal parts or degrees, beginning at E, and ending at ninety with D, and alſo the quadrant A D, into ninety equal parts, beginning at A, and ending at D, as before; then if you lay a ruler at 10 in the quadrant E D, and alſo at 10 in the quadrant A D, it will cut the line C D in a point, which call the ſine of ten degrees, and ſo you may divide it into all its other parts.

To make the Line of Latitudes E D.

Lay a ruler upon the point A, and every degree of the line of ſines C D, and where it interſects the quadrant D E, you may ſet figures agreeable to theſe in the line of ſines; then ſet one foot of the compaſſes in the point E, and with the other transfer thoſe diviſions from the arch to the line D E, and figure it as in the ſcheme.

To make an Hour Scale or Line q r, to be uſed in Dialing, with the Line of Latitudes, before deſcribed.

The Line of Tangents F E, being already made to the radius C E = D *q* = D *r*, take thence in your compaſſes the degrees and minutes, turned into time (allowing 15 deg. to an hour, in time, and one degree to four minutes) agreeable to thoſe, and lay them ſeverally from D, both ways towards the q and r, ſo will the line be divided into the time expreſſed.

To make the Hour Lines A D, *to divide a Circle into Twenty four equal parts, uſed when a Dial is to be made by the Line of Contingence, &c.*

Divide the quadrant A D, into ſix equal parts, and ſetting one foot of your compaſſes in the point A, transfer theſe parts to the hour line A D, ſo will you have the primary diviſions of that line, or having firſt made the line of chords B E, take thence the chord of 7 deg. 45 min. 7 deg. 30 min. 11 deg. 15 min. 15d. oom. 18 deg. 55 min. and 22 deg. 30 min. &c. ſtill adding 3.45 until you come to 90 deg. and ſet them ſeverally off, from A, towards D, ſo will the line be divided into every quarter of an hour; hence you ſee, that by help of this line, and the line of chords, you may reduce time into degrees of the equinoctial, or degrees of the equinoctial into time: Thus, ſuppoſe you would know what time anſwers to 37 deg 30 min. take this in your compaſſes from the line of chords, apply that extent from the hour line at A, and it will fall on 2 hours 30 minutes.

To make the Line of verſed Sines.

Lay a ruler upon every degree of the quadrant E B, and the ſame degrees of the quadrant E D, and make marks where it cuts the line A E.

do

do the ſame by the quadrants A B, and A D, until you come to the begining of the line A, then figure it as you ſee.

General Maxims belonging to Right lined Triangles.

I. A Triangle, is a figure having three ſides, as A C, C B, B A, and three angles; and A B C in reſpect to its angles, is either right or oblique.

II. A right angled triangle, hath one right angle, and two acute angles; and in making of it, there is required a perpendicular erected or let fall, as B C.

III. Thoſe ſides containing the right angle, are called legs, as the legs A B, and B C; of theſe, one is ſometimes called the baſe, as A B; and the other the perpendicular, as B C, the ſide oppoſie to the right angle, is called the hypothenuſe, as A C.

IV The three angles of every triangle is equal to two right angles, or 180 degrees; therefore having in a right angled triangle, either of the acute angles, the other is the compliment thereof to 90 degrees, ſee the figure next following.

V. In a right angled triangle, there are always two things given beſides the right angle, and one of thoſe a ſide to find a fourth.

VI. In oblique angled triangles there are three things always given to find a fourth, but one or more of theſe muſt be a ſide.

VII. The three angles of every triangle, muſt be equal to 180 deg. if in an oblique angled triangle you have any two angles, the third is the ſupplement of their ſum to 180 deg. or if you ſubtract any one of them out of 180 deg. the remainder will be the ſum of the other two; ſo in figure the ſecond, the angle at A, is 28 deg. that at B, is 46, their ſum is 74 deg. which being taken from 180 deg. there will remain the angle C = 106.

VIII. The external angle of every right lined triangle is equal to the two oppoſite internal angles.

IX. An angle may be beſt repreſented by three letters, the middlemoſt of which reſpects the angle, and that, and the other two, expreſſes the ſides which make that angle (though that ſet at the angular point may be ſufficient) ſo if one of the angles of the triangle next following, was ſet down thus, B A C, it would ſignify the angle at A, made by the ſides B A, and C A.

The Arithmetical and Geometrical Solutions, of the ſeven Caſes of Right angled plain Triangles, by Logarithms, and Canon of Artifical Sines, Tangents, and Secants.

In order to ſolve theſe ſeven caſes, it will be requiſite to premiſe the following Axiom

In all plain triangles, if one of the ſides be made radius, or ſemidiameter of a circle, the other two will be ſines, or elſe one will be a tangent, and the other a ſecant: Then it is, if the hypothenuſe be made radius, then each leg repreſents the ſine of its oppoſite angle.

If one of the legs be made radius, then the hypothenuſe reſpects the ſecant, and the other leg the tangent of the oppoſite angle to that other leg.

Example I. If the hypothenuſe be made radius, then the baſe B A, is the ſine of the angle at the perpendicular C, and the perpendicular is the ſine of the angle at the baſe B. [See Fig. 1ſt.]

II. If the baſe B A, be made radius, then the perpendicular A C, is the tangent, and the hypothenuſe B C the ſecant of the angle at the perpendicular C. [Fig. 2d.]

III. If the baſe B A, be made radius, then the perpendicular B C is the tangent, and the hypothenuſe the ſecant of the angle at the perpendicular C. [Fig 3d.]

Then it will be, as the ſide made radius is the radius, ſo is the other ſides to the ſines, tangents, or ſecants, by them repreſented; and the contrary.

N. B In the following proportions, it muſt be obſerved that when a ſide is wanting, then radius or an angle, is made the the firſt term, but if an angle be wanting, then the firſt term muſt be a ſide.

To find a ſide, any ſide may be made radius, ſaying thus, : As the word on the ſide given : is to the ſide given : : ſo is the word on the ſide required : to the ſide required.

To find an angle, one of the given ſides muſt be made radius, then as one given ſide : is to the word on it : : ſo is the other given ſide : to the word on it.

Caſe 1ſt. Given the Baſe B A = 48 : *and Angle at the Baſe* 32. deg. 37. m *to find the Perpendicular* A C. *Pl.* II. *Fig* 36.

1ſt. Make the Hypothenuſe Radius, [per Example I.]

			Co. Ar.
As S C ∠ B.	32	37	0.074535
Is to the baſe A B	48		1.681241
So is S. ∠ B	32	37	3.731601
To the perpendicular B C	30	07	1.487306

2d. by making A B *the Baſe Radius, then ſay,*

As radius	90	00	10.000000
Is to the baſe A B	48		1.681241
So is tangent ∠ B	32	37	9.806137
To the perpendicular B C	30	07	1.487378

3d. By making the Perpendicular Radius.

As tangent ∠ B	32	37	9.806137
Is to the baſe A B	48		1.681241
So is radius	90	00	10.000000
To the perpendicular B C	30	07	1.487378

Caſe

Case 2*d. Given the base* A B = 48 *and angle at the base* B = 32 deg. 37m. *to find the hypoihenuse* B C.

1ſt. By making the hypothenuſe B C radius ſay,

			Co. Ar.
As S C ∠ B	32	37	0.074515
Is to the baſe		48	1.681241
So is radius	90	00	10.
To the hypothenuſe A C	56 98 or	57	1.755776

2d. By making the Baſe Radius.

Then as radius	90	00	10.
Is to the baſe A B		48	1.681241
So is ſec. ∠ B	31	37	10.074515
To the hypothenuſe A C		57	1.755770

3d. By making the Perpendicular Radius.

			Co. Ar.
As Tang. ∠ C	32	37	9.306137
Is to the baſe		48	1.651241
So is co. ſecant ∠ A	32	37	10.208399
To the hypothenuſe A C		57	1.755777

Case 3*d. Given the hypothenuſe* A C = 57 *and angle* B = 32deg. 37m. *to find the baſe* A B. *Pl.* II *Fig.* 38.

1ſt. *By making the Hypothenuſe Radius, then will.*

As Radius	90	00	10.
Is to hypothenuſe A C	57		1.758777
So is co. ſecant ∠ B	57	23	9.925465
To the baſe A B	48		1.681242

2d. By making the Baſe A B *Radius, then will.*

			Co. Ar.
As the ſecant ∠ B	32	37	9.925465
Is to hypothenuſe A C	57		1.755777
So is radius	90	00	10.
To the baſe A B	48		1.681242

3*d*

3d. By making the Perpendicular Radius, then say.

As the secant ∠ C	57	23	9.731601
Is to hypothenuse A C	57		1.755777
So is tan. ∠ C	57	23	10.193863
To the base A B	48		1 68 1241

Case 4th. Given the Base A B = 48 *and hypothenuse* A C = 57 *to find the angles* A B C *and* B A C. *Pl.* II. *Fig.* 39

1st By making Hypothenuse Radius, then say.

As the hypothenuse A C	× 57		1 75577
Is to radius	90	00	10 00000
So is the base A B =	48		1.68124
To secant ∠ C	57	23	9.92547

2d. By making the Base the Radius.

As the base A B	48		1.68124
Is to radius	90	00	10.00000
So is the hypothenuse A C	57		1 75577
To the secant ∠ A	32	37	10.17453

Again say.

As Radius	90	00	10.000000
Is to the hypothenuse A C		57	1.755777
So is secant ∠ A	32	37	9.731609
To the perpendicular B C	30	7	1.487378

Case 5th. Given the hypothenuse B C = 57 *and perpendicular* A C = 30 7 *to find the Angles* B *and* C *and base* A B. *Pl.* II. *Fig.* 40.

1st. Making the Hypothenuse Radius, we have.

As hypothenuse A C	57		1.755777
Is to radius	90	00	10.000000
So is the perpendicular B C	30	7	1 487378
So secant ∠ A	32	37	9 73.601

2d. Making Perpendicular A B *the Radius, we have.*

As the perpendicular A C	30	7	1.437378
Is to radius	90	00	10.000000
So is hypothenuse B C		57	1.755777
To the secant ∠ C	57	21	10.268799

3d. Making the Perpendicular Radius, we have.

As radius	90	00	10.000000
Is to the perpendicular A C	30	7	1.487378
So is tangent ∠ C	57	23	10.193803
To the base A B		48	1.681241

Case 6th. Given the Base A B = 48 *and perpendicular* A C = 30.7 *to find the angles* A *and* C *and hypothenuse* B C. *Pl.* II. *Fig.* 40.

1. *Making the base* A B *the Radius, then say.*

As the base A B	48		1.681241
Is to tangent radius	45	00	10.
So is the perpendicular A C	30	7	1.487378
To the tangent ∠ A	32	37	9.830137

2d. Making the Perpendicular B C *the Radius, then say.*

As the perpendicular B C	30	7	1.487378
Is to tangent radius	45	00	10.
So is the base A B	48		1.681241
To the tangent ∠ C	57	23	10.193863

To find the Hypothenuse B C, *the Proportion is.*

As secant ∠ A	32	37	9.731601
Is to the perpendicular A C	30	7	1.487312
So is radius	90	00	10.
To the hypothenuse B C		57	1.755777

Case 7th. Given the Base A B = 48 *and hypothenuse* B C = 57, *to find the Perpendicular* A C. *Pl.* II. *Fig.* 41.

The Proportion is.

As the hypothenuse	57		1.755777
Is to radius	90	00	10.
So is the base A B	48		1.681241
To the sine ∠ C	57	23	8.925201

The hypothenuse is Radius.

As radius : hypothenuse : : so is secant ∠ A : perpendicular 90 00 : 57 : : 32 : 37 : 30.7 = A C.

The

The Uſe of Right angled plain Triangles in ſeveral Problems, about taking Heights of Objects, when Acceſſible.

PROBLEM. I.

To make an Acceſſible Altitude at one Station. *Pl.* II. *Fig* 41.

Let A B, repreſent the corner of a tower, whoſe height A B is required.

1ſt. Make choice of any ſtation as at D and directing a quadrant or any other inſtrument, ſo as that you may ſee the point A, thro' both the ſights, then obſerve where the third falls, if you uſe a quadrant, ſuppoſe 40 degrees of the limb, this is the angle A p q = A E B whoſe compliment to 90 deg. is 50 deg. = E A B = ∠ p A q.

2d. Meaſure B D, the diſtance between the ſtation and bottom of the tower, which ſuppoſe 74 yards = p q then to find the height A q, lay by caſe the firſt.

As radius	90 00	10.
Is to the diſtance B D	76	1.869232.
So is tangent ∠ A p q	40	9.923814
To the perpendicular A q	62 yds.	1.793046

Having thus found A q, which is the height of the tower above the level of the eye to be 62 yards you muſt add thereto the line B q, = D p the height of your eye which let be 5 feet, then the ſum will be 63 yards and 2 feet the height of the tower, ſee the foregoing figure.

PROBLEM. II.

By knowing the Height of the Tower A B = 63 *yds.* 2 *feet* = 191 *feet, and being upon the Top thereof at* A, *to find how far an Object, ſuppoſe at* E, *is from the Baſe* B *of the ſame.* *Pl.* II. *Fig.* 42

1ſt. From A direct the ſights of your quadrant to E and find the ∠ E A B = 50 ſuppoſe.

2. Make the height of the tower A B = 191 feet radius, then ſay,

As radius	90 00 =	10.
Is to the towers height	191	2.281032
So is tangent ∠ A	50 00	10.076187
To the diſtance of the object at E, 227.6 feet		2.307220

PROBLEM III.

By knowing the height of the Tower A B 191 *feet, to find how far off it you are, when at the Station* D. *Pl.* II. *Fig.* 43.

Subtract the hight of your eye, ſuppoſe 5 feet, out of the height of the tower, and there remains 186 feet = 62 yards = A q.

2d.

2d. *Find the* ∠ A p q = 40 *as before, then ſay.*

		Co. Ar.
As S ∠ p =	40	3.191933
Is to A q	62 yds one quarter	1.752392
So is Co. Sine	50	9.884254
To the Diſtance	73 89	1.868579

Hence it is found to be 73.89 yards diſtance from the foot of the wer.

PROBLEM. IV. *Pl.* II. *Fig.* 44.

help of a two Foot Rule, or any thing elſe of a known Length or Height, to find the Suns altitude.

Let A B, be a two foot rule, erected perpendicular to the horizontal e B C, caſting its ſhadow to C, meaſure the length of the ſhadow C, and ſuppoſe it to be 36 inches, then you will have the baſe B C, d perpendicular A B, to find the angle at the baſe A C B (by caſe .) thus making the baſs B C, radius.

As baſe B C	36 1	1.556303
o I. radius	45 00	10.
is the perp. A B	24	1.380211
the Tan. ∠ A C B	33 42	9.823909

So then the ſums altitude, is 33 42.

There are ſeveral ways uſed to find the height of objects, or their ance from the place of obſervation, without the help of trigonome- we ſhall here preſent the reader with theſe that are moſt plain and .

PROBLEM. V. *Pl.* II. *Fig.* 45.

it be required to find the Height of the Tower A B C D, *by help of a Looking Glaſs, or a Bowl of Water.*

eing upon a level with the bottom of the tower, laying down a cing glaſs or bowl of water, or rather a flat piece of poliſhed ſteel ome other metal, at ſome convenient diſtance from the foot of the er, ſuppoſe at G.

d. Walk backwards leaving the glaſs in a right line between you the corner of the tower AC until you can ſee the picture of the top , in the middle of the glaſs, your eye being then at E, and feet

l. meaſure G C and G F, and alſo the height of your eye E F, ſay, by the rule of three E G : F G : : G C : C A, the height tower required.

PROBLEM VI. *Pl.* II. *Fig.* 46.

To find the height of a Houſe, Tree, Steeple, &c by a Carpenter's Square, or any two ſtraight Rulers; ſet at right angles to one another, the angular point, bein ſet upon a ſtuff of a known length, in ſuch a manner that you may ſee the points A *and* C, *along the ſide* B A, *and the point* E, *along the ſide* B D.

1ſt The ſquare, being ſet and lines imagined to be drawn from B, to A C and E, there will be found ſeveral triangles, A B E, A B F, and E B F, all being ſimilar triangles, and a like unto the triangle A C D.

When you have meaſured F E, and A D in ſuch parts as B F, is divided into, as feet, inches, &c. then it will be, as, B E : E F : : A D : C D. the height of the houſe, tree, ſteeple, &c.

PROBLEM VII. *Pl* II. *Fig.* 47.

Let it be required to find the Diſtance of the Tower I H K L, *from a Station at* A, *or* G.

Set up a ſtaff at C, and go any convenient diſtance, ſuppoſe twenty feet from hence to F, ſo that the line EG, may be at right angles with the line A H, and there ſet up another ſtaff

2d. Walk from G, leaving it in a right line with H, any diſtance, ſuppoſe at A = 176 feet, and there ſet up a third ſtick

3d. Go from A, towards O, at right angles with A H, until you ſee the ſtick, that you ſet at E, in the ſame line with H, and that will be when you come to C, then meaſure A C, which let be = 171 feet.

4th From A C = 171 feet, ſubtract G E = AN = 120 feet, and there will remain N C 51 feet; then ſay, as C N : : C A : : N E = A G : A H = 590 $\frac{2}{17}$ feet, the diſtance required.

To draw a line in the Field, as P G, *perpendicular to another line, as ſuppoſe* A H. *you may proceed thus.* *Pl.* II. *Fig.* 49.

1ſt. Go from G, any convenient diſtance, ſuppoſe to A = 10 feet, towards H, leaving G in a right line with A, and at F put up a ſtick.

2d. Go from G 10 feet to E, leaving C, in a right line with H, and at E, ſet up another ſtick, which will be twenty feet of that at F.

3 Take a piece of packthread of about 30 or 40 feet long, with a loop at each end and double it, ſticking a pin in the middle thereof, and then put the ſtick at F, through the loop, and that at E, through the other, then move from the line A H, as far as the ſtring will let you go, nearer or farther from the tower, until you reach the middle of the ſtring where you ſtuck the pin, each half between the ſticks, at *e* and *f* being held pretty tight and kept ſo, lay it gently upon the ground,

and

and ſuppoſe it fall upon the point n, then in that point, ſet up another ſtick.

4th. Having done thus, take the loop of E and F, and put the ſtick at G through one of them, and with the reſt of the ſtring, go out towards P, until you have b, in a right line between yourſelf and G ſo will the ſtring, being laid in this poſition, as P G, be at right angles with A H, or thus meaſure three yards from G to E, then take a line nine yards long, faſtening one end by a loop at G, and the other at e, then move out until e h, be five yards, then will G h, be four yards, and ſo the triangle e h g, will be a right angled triangle, right angled at G.

NAVIGATION.

NAVIGATION teacheth how to conduct a ſhip through the pathleſs ocean (where nothing is ſeen for ſeveral days: but ſky and water) from one port to another the ſhorteſt way, and in the ſhorteſt time poſſible, to any part of the known world.

Navigation may therefore be divided into two general branches, (viz) domeſtic or home navigation, which is the coaſting or ſailing along ſhore in places not far diſtant; and in ſight or ſoundings, as between England, Holland, France, &c for the performance of which there is required the compaſs, the ſounding lead and line with a competent knowledge of the nature of the lands or coaſt, the ſoundings, ſands, ſhoals, rocks, &c. with the knowledge of the ſetting, flux or reflux of the tide.

2. Remote, which more properly is called navigation, is that whereby the induſtrious mariner directs the ſhip to any port in the habitable world, and knoweth at any time what place the ſhip is in; in reſpect to latitude, longitude, courſe or diſtance, the inſtruments that are uſed in this art, are firſt. A pair of compaſſes, a plain ſcale, a gunters ſcale, the plain and mercator's charts, a plain or common compaſs, an azimuth compaſs, a ſea quadrant, a fore ſtaff, an almicanter's ſtaff, a log line, and half minute glaſs.

A ſcheme or projection of the Meridian or parallels of the Globe in Plano, attributing how Latitude and Longitude is accounted.

Explanation. Let the circle E N Q S repreſent the circumference of the terreſtrial globe, and N the north point or pole, S the ſouth pole the circle N Q S N the general meridian, and let N S; one diameter repreſent the firſt meridian paſſing over London, and imagine a line to begirt this globe round equidiſtant from the north and ſouth poles, as E Q it is called the equinoctial (or equator,) again imagine circles to paſs,

paſs, from one pole to the other through as many degrees, or points of the equinoctial as you pleaſe as N 10 S N 30 S &c. theſe circles are called meridians, upon which latitude is accounted from the quator both ways to the north and ſouth poles to 90 deg. and the circles 10, 10. 20, 20. 30, 30. parallel to the equator, are called paralels of latitude, on the equator we count the longitude from the center C (repreſenting the firſt meridian, or London) increaſing eaſterly to 180 and weſterly to 180 deg from the ſaid meridian till the account ends in the oppoſite meridian, on the other ſide of the globe.

The diſtance of any one place from another, is the ſhorteſt line intercepted between theſe two places, on the ſurface of the earth; hence then as the terraqueous globe is a round body or ſpherical (as has been demonſtrated) all lines drawn upon the ſurface thereof muſt be ſpherical, or arches of circles, and therefore the diſtance between any two places muſt always be an arch of a circle; tho' indeed a ſmall part of our globe (it being of ſo great a magnitude in the whole) differs not to our ſenſe from a plane and the diſtances of two places not far diſtant as a right line.

Obſervation, 1ſt. Nature her ſelf has placed no particular beginning or term of the earths extention from weſt to eaſt, or from eaſt to weſt, (or according to the equator) hence any meridians may be taken for the firſt meridian or beginning of longitudes every ſuperficies whether plain or curved, is determined and meaſured by two diviſions, or extentions, the one is called the length or longitude of that figure, or ſuperficies, and the other the breadth or latitude thereof, but the figure of the earth being ſpherical the dimenſions thereof are equal; and ſo length and breadth, or latitude or longitude muſt not differ, but only according to our conceptions that theſe two terms may be more obvious to us for ſeeing that theſe meridians do all meet in the poles, of the earth which are always a ſemi circle or 180 deg. aſunder from each other, this ſemi circle we will take for one of the earths dimenſions, and ſeeing the equator's equidiſtant every where from theſe two poles, is continued without interruption to a whole circle (or 360) we will take this for the other dimenſion of this ſpherical ſurface, this being a whole circle is longer than the other, being only half a circle, therefore the equator muſt be the meaſure of the earths length or longitude, and the meridian the meaſure of its breadth or latitude.

2. The circle you ſee on a clear day, where the ſky and ſea ſeems to meet all round is called the ſenſible or viſible horizon, parallel to which at the diſtances of the earths ſemi diameter is the true horizon.

3d. The point in the heavens directly over your head in all places is called the zenith, and the point under the feet is called the nadir and are each of them 90 deg. from the horizon.

Now if we imagine circles be deſcribed in the heavens round the globe all meeting in the zenith and nadir as the meridians do in the poles,

poles, and to cut the horizon at right angles, as the meridians do the equinoctial, these circles are called azimuths in which the sun is every minute of the day, except at noon when he is on the meridian.

4th And if there be imagined parallels to the horizon upwards towards the zenith, they are almicanters or circles of altitude, or height of the sun and stars above the horizon.

5th. Amplitude of the sun or stars is their distance from the east point of the horizon to the northward of their rising, and from the west point northerly or southerly at their setting, according as the sun or stars is to the northward, or southward of the equinoctial.

6th. The course is the rhumb or point of the compass, which a ship sails on reckoned from the north or south towards the east or west, and the complement of the course, is the point of the compass steered, reckoned from the east and west towards the north, or south, or the residue (or complement) of the course when taken from 90 deg.

7th. The distance is the number of miles or leagues the ship sails upon any course or point of the compass.

8th. The difference of latitude, is the difference between the latitude sailed from, and the latitude the ship is come into.

9th. Departure or meridional distance, is the number of miles or leagues the ship hath made, east or west, from the meridian, (or north and south line) the departed from.

PRIMARY PROBLEMS.

PROB. I. *Given the Latitude of two Places, required the difference of Latitude between them.*

Rule 1st If the two places are on the same side of the equator (that is, both in north or both in south latitude) their difference is the difference of latitude required.

Rule 2d. If the places are on the contrary sides of the equator (that is if one be in north and the other in south latitude) their sum is the difference of latitude required.

Example 1st. What is the difference of latitude between the Lizard and Madera.

Lizard in Latitude	-	49.	56 N.	17.	31	Multi.
Madera Latitude	-	32.	25 N.		60	
Remains	-	17	31	10	51	Miles.

the × of lat. required.

Example

Example 2d. What is the difference of latitude between St. Jago, one of the islands of Cape de Verd, and St. Helena, an island in the Ethiopian sea?

	D.	M.			
To the lat St. Jago -	14	56 N.	30	41	Multi.
Add lat. St. Helena -	15	45 S.		60	
This sum is diff. lat. -	30	41	1841		Miles.
× of lat. required.					

PROBLEM II.

Given one Latitude and × of Latitude. Required the Latitude come to?

Rule 1st. The ship in north latitude.

1st If the course be northward, she raiseth or elevateth the pole, and increaseth her latitudes, and therefore the × of latitude (reduced to degrees and minutes) must be added to the latitude from whence the ship departed from, the sum will be the ship's latitude north.

Example. Suppose from the latitude 32. 25 N. a ship sails due north 1021 miles, or 17 deg. 31 min. I demand the latitude the ship is in?

To the lat. depart. - - -	32	25	W.
Add the differ. of lat. - - -	17	31	N.
Sum is the lat. required. - - -	45	56	N.

Example. If from the latitude 40. 30 N. a ship sail southward until the difference of latitude be 25. 15 what latitude is she in?

From latitude departed - -	40.	30	N.
Subtract × of latitude - - -	25.	15	
Remainder is latitude - - -	15	15	N.

Note. If the course be southward, and the difference of latitude reduced to deg. and min. is greater than the latitude the ship came from; subtract the said latitude from the difference of latitude, and the remainder will be the ship's latitude south, and consequently the ship hath crossed the equinoctial line, and depressed the north pole, and raised the south pole.

Example. If from the latitude of 2. 20 N. a ship sails southward till her difference of latitude be 5. 19 required what latitude she is in?

From the diff. of lat. - - -	5.	19	S.
Subtract the departed lat. - -	2.	20	N.
Remains the required lat. - - - - -	2.	20	S.

rule

Rule 2d. *The Ship in South Latitude.*

If the courſe be ſouthward, the ſhip raiſeth the ſouth pole, or increaſeth her latitude, and then the difference of latitude reduced into deg. and min. muſt be added to the latitude ſhe departed from, and the ſum ſhall be the latitude the ſhip is in.

If the courſe be northward, ſhe decreaſeth her latitude, and therefore the difference of latitude reduced to deg. and min. muſt be ſubtracted from the atitude ſhe departed from, and the remainder is the ſhip's latitude ſouth.

Note if the courſe be northward, and the diff. of lat. be greater than the latitude the ſhip came from, ſubtract the ſaid latitude from the reduced diff. of lat. and the remainder will be the ſhip's latitude north, and conſequently the ſhip hath croſed the equinoctial.

To find whether you muſt Sail Northward, or Southward, between any two Places, whoſe Latitudes are known.

1. If you ſail from a greater ſouth latitude to a leſſer the courſe is ſouthward, but if from a leſſer north latitude to a greater the courſe is northward.

2. If you ſail from a greater ſouth latitude to a leſſer the courſe is northward, but if from a leſſer ſouth latitude to a greater the courſe is ſouthward.

If a ſhip ſails from a north latitude to a ſouth latitude, the courſe is ſouthward, but if from a ſouth latitude to a north latitude the courſe is northward.

If a ſhip ſails eaſt or weſt, ſhe keeps in the ſame latitude, and makes no northing or ſouthing, but her diſtance and departure will be the ſame.

If a ſhip ſails north or ſouth ſhe keeps in the ſame longitude, and makes no eaſting or weſting, therefore her diſtance and difference of latitude is the ſame.

The CONSTRUCTION *of the* PLAIN CHART.

Theſe Charts are either General or Particular, the Geometrical Projection.

Draw the line A B for the equator and divide it into 18 equal parts, or degrees, and through each degree or (as here) each 10 degrees draw a perpendicular line which ſhall repreſent the meridians of this chart, divide theſe meridians into 90 equal parts or degrees from the equator, towards the northward or ſouthward, thereof and draw lines parallel to the equator, which ſhall repreſent the parallels or circles of latitude as the meridians did repreſent the circles of longitude; upon this chart then you may by help of a table of latitude and longitude of places aſſert or lay down the ſaid places.

But seeing (according to this chart) that the meridians have no inclination to each other, but are all parallel to each other, and divided equally as the equator; therefore if you insert these places according to their true latitudes and longitudes, then shall their course and distance disagree with the globe, and if you set these places upon this chart, according to their latitude and distance, then will their course be true, but their longitude always erronrous, as will be proved in the use of Mercator's chart.

2d. The construction of the particular plain chart is the same with that of the general and differs only in its extent, and made generally for a small part of the world, with one or more in all compasses and in the middle or corners to shew by the rhumbs or points of these the bearings or position of places and also a scale of leagues for measuring the said distances of places; the meridian is also a scale of equal degrees and may serve likewise to measure the said distances.

Lastly If each degree of the meridian is divided into as many equal parts as its breadth will admit of, the chart is rendered fit for any manner of use that it may be applied to, and

1. *To lay down any place upon this Chart, according to its Latitude and Longitude.*

1. Through the degree in the meridian answering to its latitude, draw an occult parallel of latitude.

2d Lay a ruler over the degree of its longitude and draw an occult meridian where this cuts the parallel of latitude before drawn, is the place required.

2. *To lay down any place by its Bearing and Distance from it.*

After having found out the rhumb line answering to the bearing given, through the place proposed, and parallel to the rhumb, draw a line and set off upon it (from the given place) the distance given in leagues or parts of the graduated meridian, and the point thus found will be the place required.

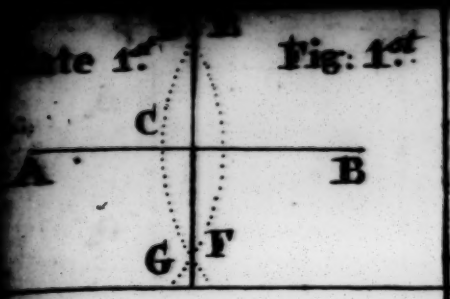
3. *If the difference of Latitude and Bearing be given.*

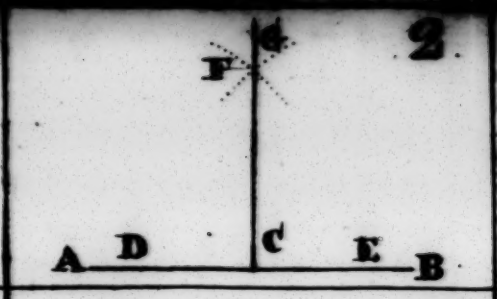
Count the difference of latitude either northward or southward (as the case requires) on the divided meridian, and from the given latitude, draw the parallel of latitude passing through the same, and lay a ruler over the place and parallel to the rhumb line given, where it cuts the parallel before drawn, it gives the place required.

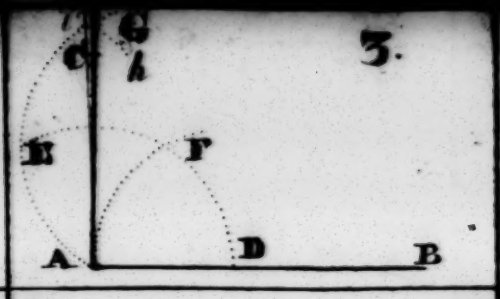
4th. *If it be by the Distance and difference of Latitude.*

Having drawn the parallel as before, (by the help of the difference of latitude) take the distance between the points of the compasses, and set one foot in the place given, and with the other cross the parallel before drawn, and you will have the place required.

Note.

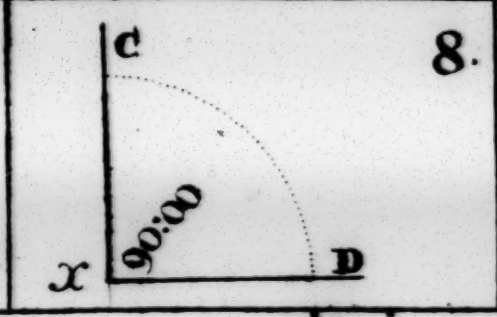

Plate 1.st
Fig: 1.st
C
A
B
G
F

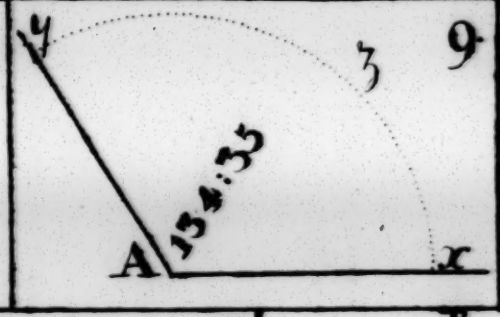

2.
F
A
D
C
E
B


3.
C
B
F
A
D
B

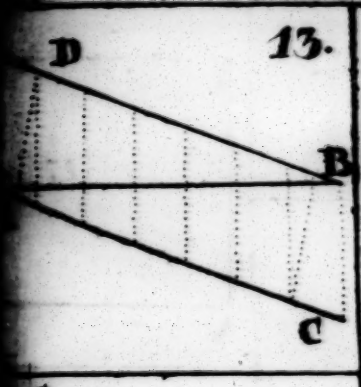

N
R

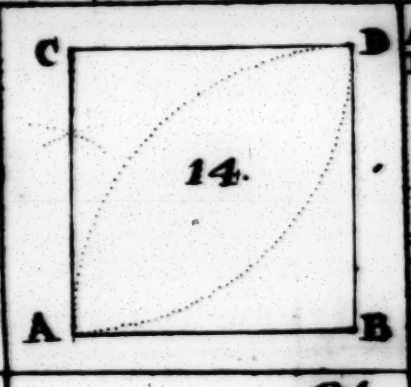

C
47:15
7.

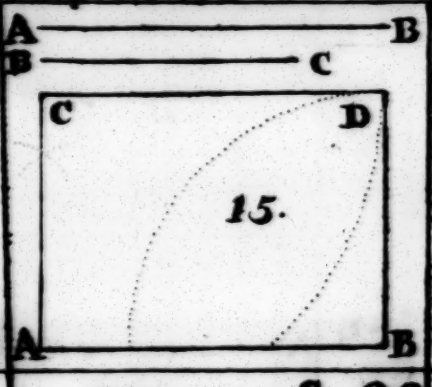

C
8.
x
90:00
D

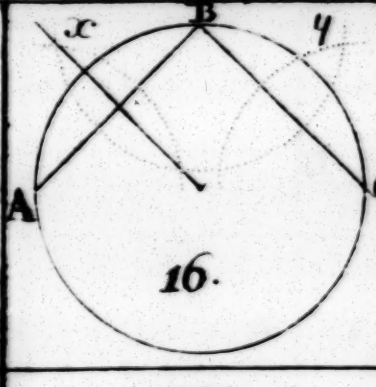

9.
134:35
A
x

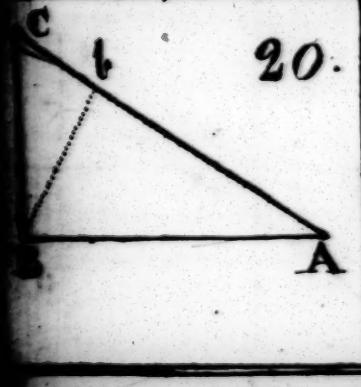


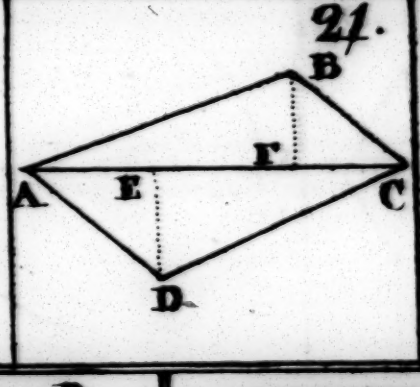

D
13.
B
C

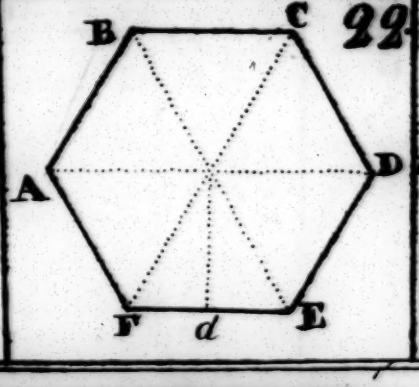

C
D
14.
A
B

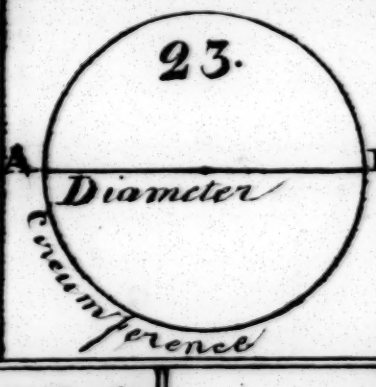

A
B
B
C
C
D
15.
A
B

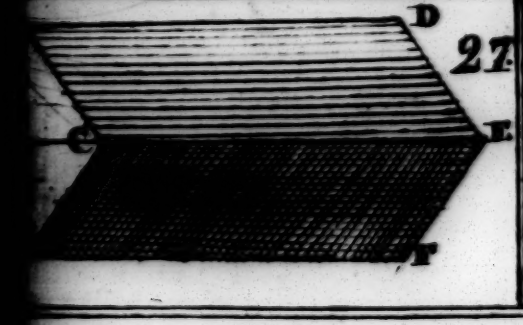

x
B
A
16.

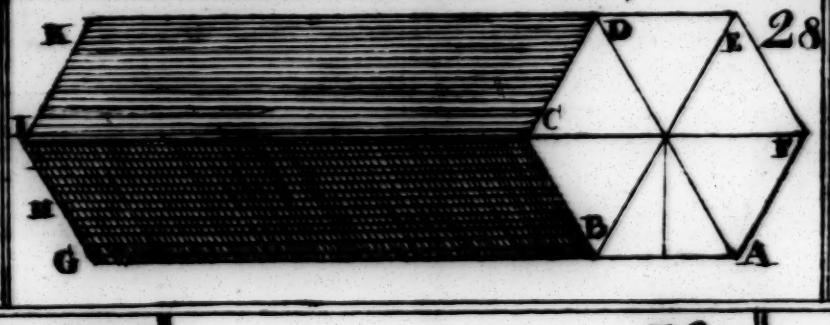

C
20.
A

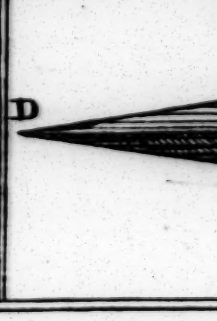

21.
B
E
F
A
C
D

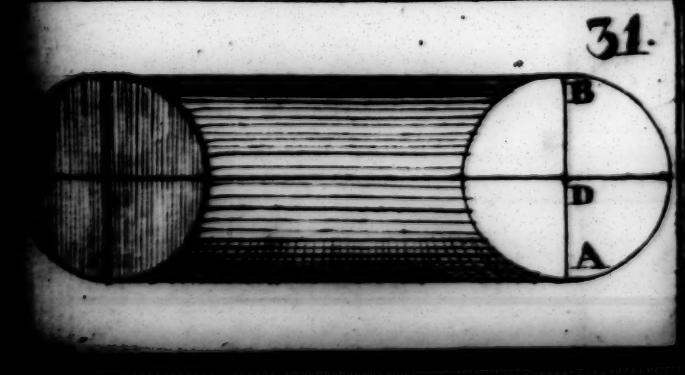

B
C
22.
A
D
F
d
E

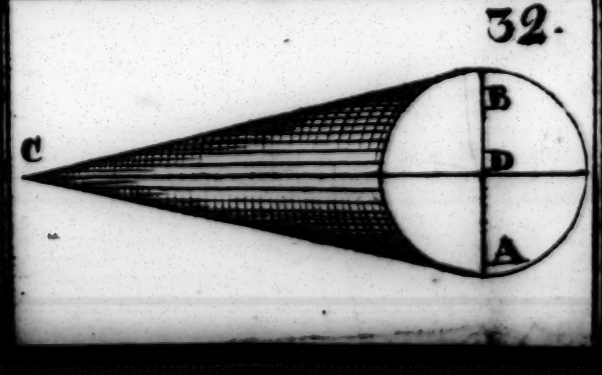

23.
A
Diameter
Circumference

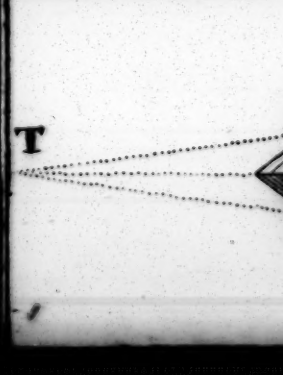

D
27.
E
F

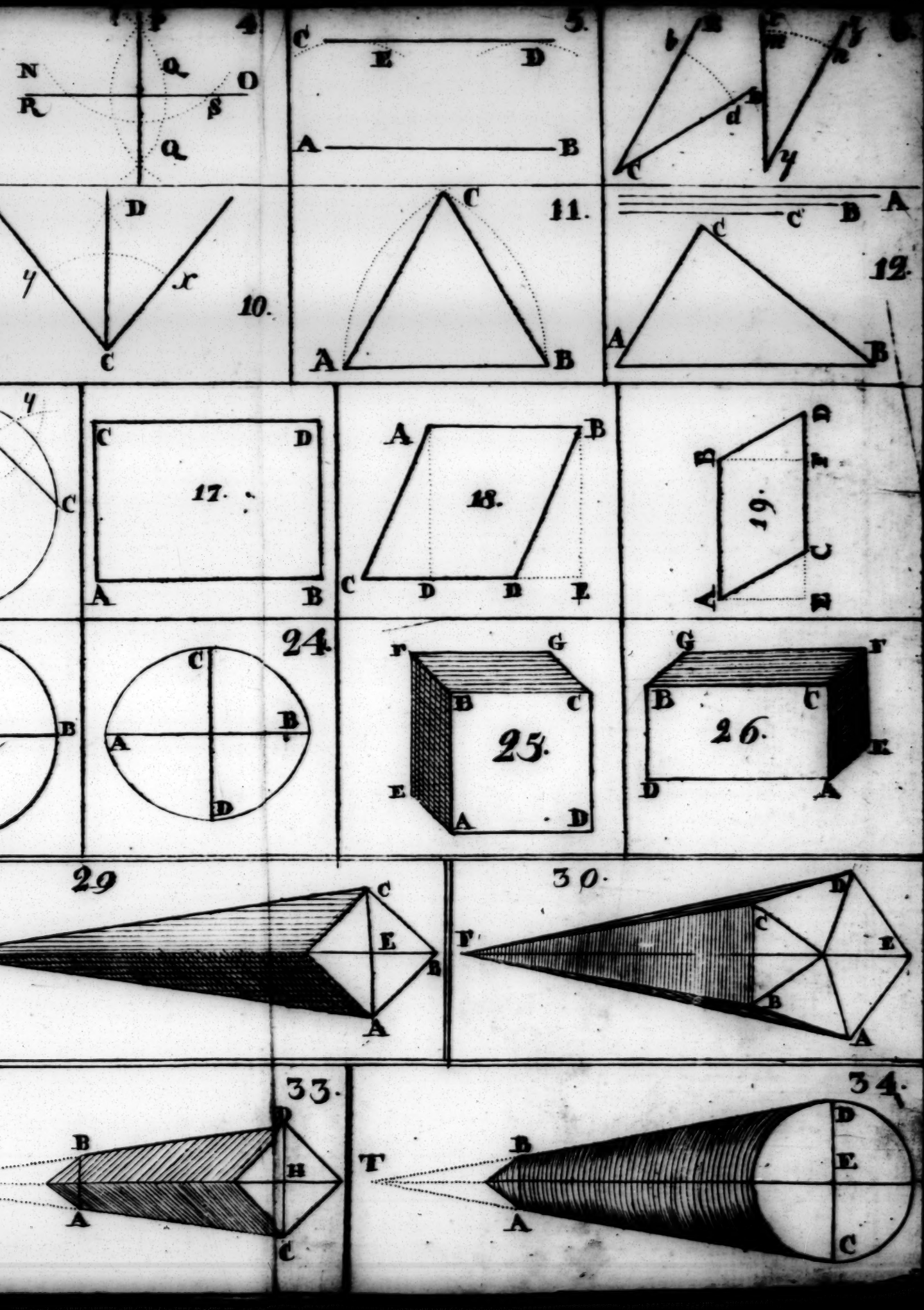

K
D
E
28.
C
F
B
A
G


D

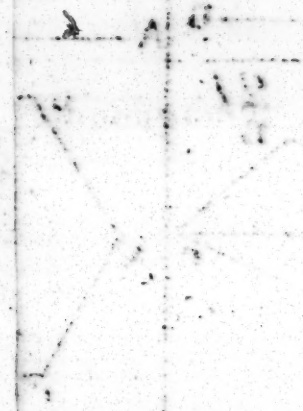

31.
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D
A


32.
C
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D
A


T


4
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A
C





Note. Difference of longitude, meridional diſtance or departure from the meridian ſignify (in the plain chart) one and the ſame thing, and the neareſt diſtance of any two meridians, it ſheweth how far one place is to the eaſtward or weſtward of another.

Examples ſhewing the Uſe of the plain Chart.

To find the latitude of any place in the chart. Example, what is the latitude of the Lizard in England.

1ſt. Take the neareſt diſtance from the Lizard, to any parallel, lay that diſtance on the graduated meridian from the ſaid parallel and the moveable foot, ſheweth 50 deg. north latitude, becauſe it is to northward of the equinoctial, and ſo for any other place.

To find the Meridional diſtance or × of Longitude between any two Places in the Chart.

Example What is the meridional diſtance (or weſting) from the Lizard to Cape Finiſtere?

Take the neareſt diſtance from the Lizard to a meridian, and moving the compaſſes with one foot on it, and the other perpendicular, till both feet come to the parrallel of Cape Finiſtere, then the diſtance from the perpendicular foot to Cape Finiſter being meaſured on the meridian is 3 deg or on the ſcale of leagues 60

To find the Courſe or bearing of one Place from another in this Chart.

Example. I demand the courſe from the lizard, to the iſland Madera?

1ſt. Lay a rulers edge on the Lizard, and the middle of madera, take the neareſt diſtance from the center of any compaſs to the ruler, and ſlide the compaſſes along by the ruler, keeping one foot perpendicular to it, and it ſheweth among the rhumb lines the courſe to be S S W half W neareſt from the firſt place to the ſecond.

4th. To find the diſtance between any two Places in this Chart.

Extend the compaſſes from one place to the other, and apply the diſtance to the ſcale of leagues or to the graduated meridian, the firſt ſheweth the diſtance in leagues, the latter in degrees, this is ſo plain and eaſy, that it needs no example.

The Latitude the Ship is in, and her Meridional Diſtance given; to find in the Chart where the Ship is in.

Lay of the meridional diſtance (according to its nature, whether to the eaſtward or weſtward) from the place (you ſailed) its counted from, and then the neareſt diſtance from that to any meridian muſt be kept

in one pair of compaſſes, and with another pair of compaſſes take the neareſt diſtance of the latitude from any parallel or eaſt and weſt line, then move both pair of compaſſes perpendicular, one to the meridian the other on the parallel, till both perpendicular feet meet and there is the place in the chart repreſenting the place of the ſhip required.

By the help of theſe propoſitions may the mariner diſcover upon what courſe, and how far he muſt ſail to arive at his deſired port as alſo to lay down his ſeveral runnings, and thence find the ſeveral places, he arrives at in the end, and ſo be able to alter his courſe anew, in order to gain any port in the ſhorteſt time poſſible, but though this way is very expeditious, and a natural repreſentation to the mind, yet I would not adviſe the young navigator to depend wholly upon it, but keep to his account by calculation according to the method hereafter ſhewn, and if at any time his curioſity ſhall lead him to examine how exact he has been will be of great uſe.

PLAIN SAILING. *Geometrically, Trigonometrically, and Inſtrumentally.*

Caſe 1ſt. The courſe and diſtance being given to find the difference of latitude and departure.

Suppoſe a ſhip in latitude 45d, 45N. ſails NE be N 207 miles; required her diff. of latitude and departure.

The Geometrical Projection. Pl. II. *Fig* .46.

Draw A B for a meridian or north and ſouth line, make the ∠ A = 3 points or 33. 45 from the line of rhumbs, or chords, on the plain ſcale, draw A C which make = 207 miles from any ſcale of equal parts, and from C let fall the perpendicular C B, and A B will be her ✕ of latitude, and C B her departure or eaſting, ∠ A = fine courſe and ∠C = fine comp. courſe, and ∠ B = radius or ſine 90 00.

2d. *Menſuration Mechanically.*

A B and B C being each meaſured on the ſcale of equal parts A C was taken from, the firſt gives 175 miles for the difference of latitude, and B C = 115 miles for the eaſting or depa rture.

Trigonometrically by Artificial Sines and Logarithms.

As radius	90 .00		10.00000
Is to the diſt.	207		2.31597
So is Sine courſe	33 .45		9.91985
To the departure	115		2.06271

As

As radius	-	90 00	-	-	10.00000
Is to the diff.	-	207	-	-	2.31597
So is S. C. courſe		56 15	-		9.91985
To the × of lat.		172	-		2.29582

Arithmetically by Natural Sines, making Radius = 1.

Then 1 : 209 : : .5556. Then 209 × : 5556 = 115 the departure.

And 1 : 207 : : .8314 Then 207 × .8314 = 172, the difference of latitude.

INSTRUMENTALLY. Extend the compaſſes from radius or ſine 90 00 to S. 33 .45 on the ſines, that extent applied from 207 on the line of numbers will give 115 for the departure.

Extend from Sine 90 .00 to S. 56 .15 on the ſines that extent from 207 on the numbers, gives 172 the departure. $\frac{172}{60} = 2\ .52$

Lat.	45	.45
Latitude the ſhip is in.	48	.37

The Uſe or Practice of this Caſe.

1ſt. By this your dead reckoning is kept; by it you may calculate the table of difference of latitude and departure; ſo very uſeful is this caſe, that you may work a traverſe or day's log at ſea, with great eaſe and quickneſs.

Note. But the given ſides and angles are marked in the projections, with (—); and the required ones with (o).

Caſe 2d. The Courſe and × of Latitude being given to find Diſtance and Departure.

Suppoſe a ſhip in latitude 48 .30 N. ſails N. W. half W. or (N. 50 38 W.) until by obſervation, ſhe is in latitude 53 .49 N. I demand her diſtance and departure?

From lat. obſerv.	50	49	From	90	.00
Sub. lat. dep.	48	30	Subtract	50	38
Remains × of lat.	2	19	S. C. Courſ.	39	22

And 2 .19 × 60 = 139

Geometrically Pl. II *Fig* 47.

Make A B = 139 from a ſcale of equal parts, and raiſe the perpendicular B C, make the ∠ A = 4 and a half points (the courſe from the chords, and draw A C, to cut the perpendicular B C in C, then is A C the diſtance ſailed, and B C the departure. To meaſure which apply AC and BC to the ſame ſcale of equal parts, the firſt gives 219 miles, the diſtance and the latter 169 miles for the weſting or departure, was required.

Trigonometrically.

As fi. com. co.	39 .22	9.30228
Is to d. of lat.	139	2.14302
So is radius	90 00	10.00000
To the diſt	219	2.34074
As radius	90 00	10.00000
Is to the diſtance	219	2.34074
So is fi. courſe	50 38	9.88824
To the dep.	169	2.22898

Arithmetically, by Natural ſines.

N. S. 39 .22 = 6353
N. S 50 38 = 7731

$6353 : 139 :: 1 \frac{139}{6353} = 219$

$1 : 219 :: 7731 : .7781 \times 219 = 169.$

Hence it appears that the diſtance found arithmetically is 219 miles, and departure 169 the ſame as before.

Inſtrumentally. Extend from fine 39 22 to fine 90 00 that extent, laid upwards from 139 on the numbers gives 219 the diſtance.

2. Extend from fine 90 00 to fine 50 38 that extent laid down wards from 219 on the numbers gives 169 miles for the departure being the ſame as before.

A TABLE *of given natural Sines or given Numbers.*

Points.	Latitude.	Departure	Points.
$0\frac{1}{4}$	.9988	.0488	$7\frac{1}{4}$
$0\frac{1}{2}$	.9952	.0976	$7\frac{1}{2}$
$0\frac{3}{4}$	.9892	.1466	$7\frac{1}{4}$
1	.9808	.1951	7
$1\frac{1}{4}$	.9701	.2427	$6\frac{3}{4}$
$1\frac{1}{2}$	.9570	.2899	$6\frac{1}{2}$
$1\frac{3}{4}$	.9416	.3371	$6\frac{1}{4}$
2	.9239	.3827	6
$2\frac{1}{4}$	.9040	.4276	$5\frac{3}{4}$
$2\frac{1}{2}$	.8820	.4713	$5\frac{1}{2}$
$2\frac{3}{4}$	.8578	.5138	$5\frac{1}{4}$
3	.8315	.5556	5
$3\frac{1}{4}$	.8832	.5955	$4\frac{3}{4}$
$3\frac{1}{2}$	.7729	.6345	$4\frac{1}{2}$
$3\frac{3}{4}$	.7410	.6715	$4\frac{1}{4}$
4	.7071	.7071	4

Note. The navigator muſt be ſure to take an obſervation by the ſun, or ſtars, as often as he has opportunity (every noon and at night) and ſee that the courſe be truly ſteered, and then if he finds the difference of latitude from yeſterday's obſervation, diſagree with the difference of latitude by dead reckoning, found by the firſt caſe, then let him take the courſe ſteered, and the obſerved difference of latitude and find the corrected diſtance and departure by this ſecond caſe of plain ſailing.

Caſe 3d. The Courſe and Departure being given to find the Diſtance and difference of Latitude.

Suppoſe a ſhip in latitude 31 deg. 19m. N ſails N W by N half W making her departure 188 miles what is her diſtance run, difference of latitude and the latitude ſhe is come to. *Pl*, II, *Fig*, 48.

Geometrically. Make the angle B A C = 3 points and a half = 39 deg. 22m. with the departure 188m. draw DC parallel to the meridian AB, till it meet the diſtance A C produced in C the ſhip's place.

From the point C let fall the perpendicular B C and A C and B A meaſured on the equal parts you protracted A D from, gives A C 289 the diſtance and A B _ 223 the difference of latitude required.

Trigonometrically.

As ſi. courſe	39 22	9.800228
Is to the dep.	183	2.262414
So is radius	90 00	10.000000
To the diſt.	289	2460169
As radius	90 00	10.000000
Is to the diſt.	289	2.460169
So is S. C. C.	50 38	9.888237
To the d. of lat.	223	2.348306

Arithmetically by Natural Sines.

Nat. ſi. 39.23 = 6353
Nat. ſi. 50.38 = 7731
6353 : 183 :: 1 : 0353) 183.0000(289 the diſtance.

1 : 289 :: 7731 : 7731 × 289 = 223 the difference of latitude.

And $\frac{223}{60}$ = 3 deg. 43m. latitude 31 19 north.

Difference of latitude 3.43 north

Latitude come to 35.02 north as required.

Inſtrumentally. Extend the compaſſes from ſine courſe 9 22 to 90 .00 on the ſines, that extent reaches from 183 to 299 on the numbers, the diſtance.

Extend from ſine 90 .00 to ſine 50 .38 that extent applied from 289 to 223 on the number gives the × of latitude 223.

Caſe 4th. The Diſtance and × of Latitude being given to find the Courſe and Departure.

Suppoſe a ſhip ſails in the S. W. quarter from the latitude 35 .02 N. making

making her diſtance 289 miles and then by obſervation is in latitude 31 .19 N. what courſe hath ſhe ſteered, and what is her departure.

From	35	.02	3	.43
Sub.	31	19	60	
× Lat.	3	43	223	

Geometrically. 1ſt. Draw A B, the meridian, on which ſet 223 miles or the × of latitude from A to B, and as the courſe is weſterly raiſe the perpendicular B C towards the left hand, with the diſtance ſailed 289 miles or equal parts in the compaſſes, ſetting one foot in A the place departed from, with the other croſs the perpendicular in C the place the ſhip is in. *See Pl* II *Fig* 49.

Menſuration. Meaſure the arch of the angle of the courſe on the chords gives 39 deg. 30m. the courſe ſouth weſterly, alſo apply B C to your ſcale of equal parts and it gives 184 miles the departure.

Trigonometrically.

As the diſt.	289	2.460590
Is to radius	90 00	10.000000
So is di. of lat.	223	2.348305
To ſi. c. courſe	50 30	9.887407
Sub. from 90 00 gives	39 30	ſi. co.
As radius	90 00	10.000000
Is to the diſt.	289	2 460898
So is ſi. cou.	39 30	9.303610
To the dep.	184	2 264308

Arithmetically by Natural Sines.

$289 : 1 :: 223 : \frac{223}{289} = 7716$ the ſine of 50 30 ſubtract from 90 00 leaves 39 30 = the ſine courſe its natural ſine 6361.

1 : 289 :: 6361 : 184 anſwer the courſe 39 deg. 30m. weſterly or S W by S half W and departure 184 miles Q E I.

Inſtrumentally. Extend from 289 to 223 on the line of numbers, that extent laid from radius or ſine 90 00 gives ſine 50 .38 the S. Co. courſe; then extend from ſine 90 .00 to ſine 39 .30 that extent laid from 289 on the line of numbers downwards, gives 184 miles the departure required.

The uſe of this caſe is when you miſtruſt the care of him that ſteers the ſhip, that he has let her fall off, or that you have neglected the variation, or met with thwarting currents, and aſſured your diſtance is right by the log, then with this diſtance and the true × of latitude by obſervation find the courſe and departure by the fourth caſe of plain ſailing.

Caſe 5th. The Diſtance and Departure being given, to find the Courſe and × of Latitude.

Suppoſe a ſhip in the latitude of 40 deg. 15 min N ſails in the N. E. quarter 315 miles, until her departure or eaſting is 277 miles,

I desire to know the course she has steered and latitude she is come to?

Instrumentally. Extend from 315 the distance to 277 miles the departure, that extent applied the same way from sine 90 00 gives sine 61 38 the sine course. The extent from sine 90 00 to sine 28 29 the S. C. course, laid from 315 on the numbers downwards, gives 149 6 miles, the difference of latitude required.

Geometrical Projection. Pl. II. *Fig.* 50.

Draw the meridian A B, and erect the perpendicular B C, which make = 277 miles the departure, with the distance 315 miles in your compasses, and one foot in C, the ship's place, the other will cross the meridian in A, the place departed from, then draw A C the distance sailed N. the course, and × of latitude A B, measured as in the case before, you find the course N. 61.39 easterly, and the × of latitude 149.6 miles.

Trigonometrically,

As the dist.	315	2,498311
Is to radius	90 00	10,000000
So is dep,	277	2,442480
To sin. cou.	61 39	9,944169
As radius	90 00	10,000000
Is to the dist.	315	2.491311
So is si. c. c.	28 21	9.676532
To the di. la,	14 ,96	2,174843

Arithmetically by Natural Sines.

315 : 1 :: 277 : $\frac{277}{315}$ = .8793 is the N. S. 61 .39.

From	90 00
Subtract	61 39
N. S. thereof	28 21
Is ,4748	

And .4748 × 315 = 149 54

Answer. The course is N 61 ,39 Easterly or E. N. E. half E. nearly and her departure 149.6 miles as required.

$\frac{150}{60}$ = 2 .30 N.
40 15 N.
42 45 N. } Latitude comes to 42 45 N.

Case 6th. the Difference of Latitude and Departure being given to find the Course and Distance.

Suppose a ship in latitude 50 33 N. sails in the S. E. quarter until her × of latitude be 220 miles and departure 108 miles, I demand her course, and distance, and latitude come to.

Geometrical Projection. Pl. II. *Fig.* 51

Make A B, on the meridian equal 220 miles, the × of latitude.

Raise

Raiſe the perpendicular B C, which make equal to 108 miles the departure, draw A C, then the ∠ B A C, is the courſe: and A C the diſtance of the ports, and are meaſured as the 4th caſe before going.

Trigonometrically.					
As the dif. lat.	220	2.34242	As S. courſe 23 09		9.64416
Is to tan rad.	45 00	10.00000	So is Departure 108		2.03340
So is the dep.	108	2.03342	So is Radius 90 00		10,00000
To tan. courſe	23 09	9 69100	To the Diſtance 245		2,38926

The courſe is N N W ſomewhat more than half deg. weſterly, the diſt. 245 miles $\frac{220}{60} = 3\ ,40$

50 33 N. lat. dep.
3 40 N. × lat.
46 53 N. lat. come to.

Arithmetically,

220 : 1 :: 108 : $\frac{108}{220} = ,4909 =$ natural tangent × 23,08 whoſe natural ſine is 4405 then ſay,

4405 : 108 :: 1 : $\frac{108}{4405}$ that is

4405)108,0000(= 245 the diſtance required.

Inſtrumentally,

Extend from 220 the difference of latitude to 108 the departure on the numbers that extent applied from tangent radius on the tangents gives 26 08,

Again extend from S. 23 09 to S. 90 .00 upon the ſines, that extent applied from 108 upwards on the line of numbers gives 245 the the diſtances.

Queſtion 2d Suppoſe a ſhip ſails between the north and weſt until her × of latitude 309 miles, and departure be 456 miles, I demand the courſe and diſtance?

Geometrical Conſtruction. Pl. II. *Fig.* 52.

Of this figure is the ſame as in queſtion before going Inſtrumentally. Extend from 309 the × of latitude 456 the departure, that extent laid from tangent 45 deg. oom. gives tangent 55 53 that is increaſing from 45 00 towards the left hand.

Then extend from ſine 55d 53 to ſine 90d 00 that extent laid from 456 upwards toward the right hand on the numbers gives 550.8 the diſtance required.

Trigo-

Trigonometrically.

As the ✕ of lat.	69	2.489958
Is to tan radius	45. 00	10 000. 00
So is the depar.	456	2.658965
To the ✕ course	55. 53	10.169007
As S. course	55. 53	9.917972
Is to the depar	45 6	2.058905
So is radius	90 00	10.000000
To the dist.	550.8	2740989

Arithmetically.

309 : 1 : : 456 : $\frac{456}{309}$ = 1.4757 the N. Tan. 55 53, whence its n. si. is 8279. Then say, 8279 : 456 : : 1 : $\frac{456}{8277}$ = 550 8

Hence the course is N. 55 deg. 53 m. westerly, or N. W. by W. nearly, and the distance 550.8 m. as was required.

Note, the distance is easily found arithmetically by the square root, as followeth.

309	456	Square ✕ of lat.	95481
309	456	Square departure	207936
2781	2736	303417(550.8	303417
9270	2280	20.	
95481	1824	10)534	
	207936	525	
		1100)9'700	
		88064	
		3636	Here the square root is 550.8 the dist.

Note. In the first of the instrumental extents, when the departure happens to be greater than the ✕ of latitude, you must count the course increasing from tang 45 deg. 00 m. towards the left hand, if the ✕ of latitude be greatest as in the former example, as in this case, count it from the left hand towards 45 deg. or the right, if the ✕ of latitude are equal numbers, then your course is always 45 deg. 00 m. from the meridian.

I might have given other varieties in calculation of these six common cases of plain sailing, as in making each side the radius of a circle, but as that is done in plain trigonometry, I leave it to the learners curiosity to make the application here.

This 6th. case is of continual use at sea when we have corrected our courses from the log, and found the ✕ of latitude and departure, made by the traverse table, to find the ships course and distance made good.

Practical Questions attended with more difficulty than the former.

Question 1st. Admit a ship in 2 deg. 10 min, south latitude, sails

N. E. by E. and a quarter E. 119 leagues, required what latitude she is in then, and what is her departure.

119 × 3 = 357 miles three points and a quarter = 36deg. 34 m.

As radius	90 00	10.000000
Is to the distance	357	2.552668
So is sine course	36 34	9.775070
To the departure	212.7	2.327738

6|0)286(

× Lat. 4.46

As radius	90 .00	10.000000
Is to the dist.	357	2.552668
S. C. Course	53 .26	9.904504
To the × of lat.	286	2.957172

	D	M	
Lat. departed from	2	.10	S.
× of Lat.	4	46	N.
Latitude come to	2	36	N.

Arithmetically.

N. S. of 36 34 = 5957
N. S. 53 26 = 5032

1 : 357 : : 5957 : 357 × .5957 = 212. 66490
1 : 357 : : 8032 : 357 × 7032 = 286. 57474

Question 2d. A ship sailing S. S. W. from a port in latitude 1 deg: 30 min. north, and then by observation the ship is in 3 deg. 03 min. south latitude, I demand her distance and departure?

Latitude	1	.30	N.
Latitude	3	.03	S.
	4	33	
	60		
Dif. of Lat.	273		

Trigonometrically.

As S. Co. cou. 67 .30		9.965615
Is to the × of lat. 273		2.436169
So is radius	90 00	10.000000
To the distance 295.5		2.470548

As radius	-	90 .00	10.000000
Is to the dist.	-	295.5	2.470548
So is Sine course	-	22 .30	9.552840
To the departure		105.5	2.023388

Answer. The distance 295.5 and departure 105.5

Question 3d. A ship sails S. S. W. half W. from the latitude 2 .30 S. until the departure be 59 leagues, I desire to know what is her distance run and latitude come to.

As

Trigonomitrically.

As ſi. courſe	28 .07	9.6-3268
Is to the dep.	59	1.770852
So is radius	90 00	10.000000
To the diſt.	125.2	20975434
As radius	90 00	10.000000
Is to the diſt.	125.2	2.097:84
So is S. C. C.	61 53	9.945464
To the × of lat.	110.4	2.043048

From	90 00	
Subtract	28 07	
S. C. C.	61 53	
	110.4	
	3	
	6|331.2	
	5 31	× of lat. S.
	2 .30	lat. S.
	8 .01	lat. come to S.

Queſtion 4th. Suppoſe a ſhip ſails 360 miles in the ſouth weſt quarter from the latitude 1 .59 north, until by obſervation ſhe be in 4 .49 north latitude, required the courſe and departure?

Lat. obſerved	4 .49 S.	
Lat. departed	1 59 N.	
× of lat.	2 50	
	60	
	170	
	90 .00	
	28 11	
	61 49	

As the diſt.	360	2.556302
Is to radius	90 00	10.000000
So is × of lat.	170	2.230449
To ſi. c. courſe	28 11	9.674147
As radius	90 00	10.000000
Is to the diſt.	360	2.556302
So is ſi. cou.	61 49	9.995193
To the dep.	317.3	2.501495

$360 : 1 :: 170 : \frac{170}{360} = .4722$ the N. S. of 28.11 and $\sqrt{1-\sqrt{.47^2 \cdot 9}} = .8814 =$ N. S. 61 deg. 49 min. the courſe, and $360 \times .8814 = 317.3$ the departure.

Or S. W. by W. half W. the anſwer.

Queſtion 5th. Suppoſe a ſhip ſails 354 miles in the N. E. quarter, from the latitude 2 deg. 19 min. ſouth until her departure be 150 miles, required he courſe and what latitude ſhe is in then?

As the diſt.	354	2.549003
Is to radius	90 00	10.000000
So is dep.	150	2.176091
To the ſin. cou.	25 04	9.627088

As radius	90 00	- - -	10.000000
Is to the diſt.	354	- - -	2.549003
So is ſi c. c.	64 56	- - -	9.957040
To the X lat.	320.7	- - - -	2.546043

$\frac{320}{60} = 5.20$ N.
Sub. 2 09 S.
Lat. in 3 11 N.

Anſwer. The courſe is N. 25 04 Eaſterly or N. N. E. a quarter E. and latitude come to 3 .11 N.

Queſtion 6th Sailing in the N. W. quarter from a certain port in latitude 1 59 S. and then arriving at another port in 3 .08 north latitude, which is alſo 209 miles to the weſtward of the firſt port, I demand the courſe and diſtance from the firſt port to the ſecond.

1 .59
3 09
5 07
60
307

As the X of lat.	307	2.433138
Is to Tangent radius	45 .00	10.000000
So is the Departure	209	2.320146
To the S. Comp.	34 1	9.833008

As S. C. : departure : : radius : diſtance 34 15.209 : : 90 : 369.7

Courſe N. 34 .15 weſterly, diſtance 369.7 miles.

TRAVERSE SAILING.

WHEN a ſhip ſteers ſeveral courſes in 24 hours, then the reducing of all theſe into one, and thereby finding the courſe and diſtance made good upon the whole, is commonly called the reſolving a traverſe.

At ſea, they commonly begin each days reckoning from the noon of that day, and from that time they ſet down all the different courſes and diſtances ſteemmed by the ſhip, till noon the next day upon the log board, then from theſe ſeveral courſes and diſtances had from the compaſs and log line, they compute the difference of latitude and departure for each courſe [by caſe 1ſt. of plain ſailing] which are ſet down in a table called the traverſe table; which conſiſts of five columns, in the firſt of which are placed the courſes and diſtances, in the

the two next the difference of latitude belonging to these courses, according as they are north or south, and in the two last are placed the departures belonging to these courses, according as they are east or west. Then they sum up all the northings, and all the southings, and the difference of these is the difference of latitude made good by the ship the last 24 hours which will be north or south according as the sum of the northings and southing is greatest, the same by taking the sum of all the eastings and westings, and subtracting the lesser of these from the greater, the difference of these will be the departure made good by the ship the last 24 hours, found as above, they find the true course and distance made good upon the whole by the 6th, case of plain sailing as also the course and distance to the intented port.

To Divide the Log Line.

It is concluded that 316800 feet makes a degrees, or 60 miles or minutes, then shall one mile or minute contain 6000 feet, this divided by 120 the number of half minutes in an hour, gives 50 in the quotient, being the distance between knot and knot on the log line, then it follows that if a ship run out one of these knots in half a minute, she runs one mile in an hour; and when the log is heaved but once in two hours then the distance of every course is doubled.

To Divide the Log Lines to any Glass.

I desire to divide the log line to a half minute glass of 27 seconds.

Then the proportion is, as 30 the seconds in half a minute: : is to 50 feet distance between knot and knot: So is the length of any glass in seconds: to the distance between knot and knot.

30 : 50 : 27
27

350
100
---
30)1350(45

Question 1st. A ship bound to a port, distant 120 miles N. E half E. sails S S. E. 30 miles, then N. E. by N 40 miles, E. by N. 25 miles, and N. N. E. 44 miles; I demand the course and distance made good, and also the course and distance to the port bound for.

The Geometrical Projection. Pl. II. Fig. 59

First draw the line K H, at pleasure for a meridian or north and south line, and therein take a point as at A for the port sailed from, then with 60 from the chords and one foot in A, draw the arch L m, upon which set off two points from L to m, and draw the line A m, upon which set of the distance 30, from A to B, then is your ship at B, then let fall the perpendicular B K, then is A K 27 7 the difference of latitude, and B K = 11 .05 for the departure of the first course.

Then

Then for the ſecond courſe with the diſtance B K, draw the parallel B N, and with the chord of 60 as before, ſet off the ſecond courſe and diſtance N E. by N 40 from B to C, and let fall the perpendicular C L, then is your ſhip at C the difference of latitude, upon that courſe is 33 .3, and the departure C L = 22 .2

Then proceed in the ſame manner with the third courſe, with the parallel; ſet off E. by N. 25 from C to D, and draw the line D P, (from which ſet off the laſt courſe N. N E 44; then is your ſhip at E, now ſeeing the ſhip come from A and is now at E, the line A E meaſured on the ſame equal parts, upon which all the other diſtances were taken, will be found to be 90 miles, and the arch R Q, meaſured on the rhumbs is five points or 56 .15 (viz) N. E. by E. from the port ſailed from.

Now to find the courſe and diſtance to the port bound for, Set off four points and a half upon the arch R Q, from R to S and from A through S draw the line A S, upon which ſet off 120, (the diſtance from the port ſailed from to the port bound for) from A to E, and the ſhip being but at F. therefore the line E F meaſured on the ſame equal parts that the reſt was taken from, will give 31, and the arch T V meaſured on the chords is 35 12 or N. E. by N. ſome what Eaſterly.

By the TRAVERSE TABLE, By *Inſpection.*

				× of Lat.		Departure	
N.	Courſes	diſt.	pts.	N.	S.	E.	W.
1	S. S. E.	30	2		27.7	11.5	
2	N.E.byN.	40	3	33 3		22.2	
3	E. by N.	25	7	4.9		25 5	
4	N. N. E.	44	2	40.6		16.8	
				78.8		75.0	
				27.7			
				51.1			

Here the ſum of the eaſtings are 75 miles, which is the departure;

the ſum of miles northing is	78 .8
Southing ſubtract	27 7
Remains, which is the difference of lat. made good	51 1

Then

Then ſay, As × lat.	151		As S. courſe	56	.00
Is to tangent radius	45	.00	Is to the departure	75	
So is the dep.	59		So is radius	90	00
To the tang. courſe	56	00	To the diſtance	91	

The GENERAL RULE.

When the courſe is N. eaſterly place the × of latitude in the north column, and the departure in the eaſt column; but when the courſe is S. weſterly place the × of latitude in the ſouth, and the departure in the weſt column.

In this queſtion here is a place propoſed to be ſailed to, diſtant 129 miles, N. E. half E. the difference of latitude for that courſe and diſtance is found = 76 .2 and the departure 92 .8 miles. Now the × of latitude made good by the ſhip is but 51 .1 which ſubtract from 76 2 there remains 25 .1 the difference of latitude from the ſhip to the place bound for; alſo the departure made good by the ſhip is 75. ſubtract from the whole departure 92 .8 the remainder 17 .8 is the departure from the ſhip to the port bound for; And then you have the × of latitude 25 .1 and the departure 17 .8 to find the courſe and diſtance by caſe VI. and the neareſt to theſe two numbers that can be found in the table is 25 .4 and 17 8 over which you have 35 deg. for the courſe, and againſt it 31 miles for the diſtance, viz N E by N. 1 deg. 15 min. Eaſterly 31 miles = the courſe and diſtance the port bound to.

But ſuppoſe the × of latitude made good by the ſhip was more than the × of latitude to the port bound to, then ſubtract the leſſer from the greater and the remainder is the × of latitude from the ſhip to the port, but of a contrary denomination, which ſeems to be ſo plain that it needs no example.

Queſtion 2d. A ſhip from a certain port A, bound for a port at K, which bears S. W. from A, diſtant 55 leagues, but meeting with contrary winds, ſhe ſails N N. W. 68 leagues, then S S. W. 70 leagues, then E. half N. 90 leagues, then W. N. W half N. 70 leagues, then S. 25 leagues, then E. half S 45 leagues, then S 30 leagues; I demand the courſe and diſtance made good, with latitude come to?

The Geometrical Projection without new meridians. *Pl.* II. *Fig.* 60

Firſt draw the meridian line M R, in which aſſume a point as at A; ſet of the firſt courſe and diſtance, viz. N. N W. 68 from A to B, then for the ſecond courſe with the chord of 60, and one foot in B, draw the arch T W, upon which ſet off the next courſe S. S. W. 70 miles; Take the number of points, between the point oppoſite to the laſt courſe

courſe ſailed, and the point you are next to ſail; the reaſon of this rule is this, if from A to B, the courſe is N N W. then back from B to A, will be S. S. E. the oppoſite point, and then if you were to ſail S. by E. it muſt be one point to the ſouthward of that S. S. E. line; if ſouth it is two points, and conſequently your courſe being S. S. W. we ſet off four points, from T to W, and through W, draw the line B C, which is a S. S W. line, upon which ſet off 70m from B to C, and then is your ſhip at C; Then for the third courſe, if from B to C be S S. W. then from C to B, is N. N. E. but the next courſe being E half N. the points between N N. E. and E. half N are five points and a half, therefore with the chord of 60 and one feet in C, draw the arch x y, upon which ſet off five points and a half from x to y, and through y draw the line C D upon which ſet off 90 miles from C to D, then is your ſhip at D, after the ſame manner, laying down all the reſt as D E, W. N. W. half W. 70 then E F, ſouth 25, then F G, E. half S. 45, then laſtly G H ſouth 30, which is the laſt courſe then your ſhip being at H, and the port ſailed from at A, the line A H = 28 miles is the diſtance made good, and the ∠ at A is four points = S. E. but the port intended for being S. W. 55 miles, I ſet it off from A to K. but the ſhip being at H the line H K being 62 miles is the diſtance from the ſhip to the port bound for and the courſe is found by meaſuring the ∠ at H = 71deg 48 min. or W. S. W. more than a quarter weſterly.

By the TRAVERSE TABLE.

				× of lat.		Departure	
N.	Courſes.	diſt.	pts	N.	S.	E.	W.
1	N. N. W.	63	2	62.3			26
2	S. S. W.	70	2		64.7		26.8
3	E. ½ N.	90	7½	5.5		89.6	
4	W. N. W. ½ N.	70	5½	33			61.7
5	South.	25	0		25		
6	E. ½ S.	15	7½		4.4	44.8	
7	South.	30	7.		30		
				100.8	124.1	1344	14.5
						1145	
						19.9	

North-

Northings	104.6
Southings - -	124.1
Difference of latitude - -	19.5
Eaſtings - - -	134.4
Weſtings - -	114.5
Departure - - -	19.9

Hence by the traverſe tables we find the × of latitude 20 and departure 20 neareſt in miles; the courſe made good is 4 points or 45 deg. then ſay,

As ſine 45 .00 : ſi. 90 .00 : : 20 : 28 .3 miles, the diſtance made good from the port departed from; but the port intended for bearing S. W. 55 leagues from the port departed from, its × of latitude 40 leagues ſouth, and departure 40 leagues weſt, and ſhips × of latitude 20 leagues eaſt; hence it appears that the ſhip's × of latitude to the port bound to is 20 leagues, and her departure is 40 + 20 = 60 leagues weſt; now having the × of latitude and departure, we find the courſe and diſtance as under.

As the difference of latitude	20 .
Is to the tangent radius	45 00
So is departure	60 00
To the tangent courſe	71 .34
As S. Courſe	71 .34
Is to the departure	60
So is radius	90 .00
To the diſtance	63 .3

Here follows ſeveral curious Queſtions, which will afford Ornamental Figures for the Learner's Book.

Suppoſe a ſhip from the latitude 50 .51 north, ſails theſe courſes, (viz.) S. E. by S. 29 miles, N. N. E. 10 m. E. S. E. 50 m. E. N. E. 50 m. S. S. E. 10 m. N. E. by N. 29 m. Weſt 26 m S. S. E. 10 m. W S. W. half W. 42 m. North 115 m. E. half N. 62 m. N. 7 m. W. 62 m. North 10 m. Weſt 9 m. South 10 m. Weſt 62 m. South 7 m. E half S. 62 m. South 115 m. W. N. W. half W. 42 m. N. N. E. 10 m. I demand the courſe and diſtance made good, with the latitude come to.

By the TRAVERSE TABLE, By *Inſpection.*

N.	Courſes.	Diſt.	Pts.	× of lat. N.	× of lat. S.	departure E.	departure W.
1	S. E. by S.	29	3		24.1	16.1	
2	N. N. E.	10	2	9.2		3.8	
3	E. S. E.	50	6		19.1	46.2	
4	E. N. E.	50	6	19.1		46	
5	S. S. E.	10	2		9.2	3.9	
6	N. E. by N.	29	3	24.1		16.1	
7	Weſt.	26	9				26
8	S. S. E.	10	2		9.2	3.8	
9	W. S. W. ½ W.	42	6¼		12.2		40.2
10	North.	115		115			
11	E. by N. ½ E	62	7	6.1		61.7	
12	North	7		7			
13	Weſt.	62	8				62
14	North	10		10			
15	Weſt	8	8				8
16	South.	10			10		
17	Weſt.	62	8				62
18	South.	7			7		
19	E. by S. ½ E.	62	7		62	61.7	
20	South	115			115		
21	W N. W. ½ W.	42	6	12.2			40.2
22	N. N. E.	10	2	9.3		3.8	

Sum of Northing	211.6
Sum of Southing	211.9
Sum of Eaſtings	263.2
Sum of Weſtings	238.4
Remains	24.8

Here the diſtance made good due eaſt 24.8 miles, ſhe being arrived in the ſame parallel of latitude ſhe departed from.

Queſtion 4th. Admit a ſhip in latitude 36 .18 N. ſails theſe ſeveral courſes, viz. Weſt 23 miles, N E 20 miles, North 8 miles, Weſt 16 North 50 miles, N E 29 miles, S E 29 miles, South 50 miles, Weſt 16

16 miles, South 8 miles, S E 26 miles, West 23 miles, North 75 miles S E 7 miles, S W 6 miles, S E 50 miles, N E 14 miles, N W 50 miles, S W 6 miles, N W 7 miles N E 7 miles, S E 6 miles, N E miles, N W 14 miles, S W 50 miles, S E 6 miles, S W 7 miles, N W 7 miles, N E 6 miles N W 50 miles, S W 14 miles, S E 50 miles, N E 6 miles, S E 7 miles, S W 7 miles, N W 6 miles, S W 50 miles, S E 14 miles, N E 50 miles, N W. 6 miles, N E 7 miles; I now desire to know my course and distance made good with the difference of latitude and departure, and latitude come to.

The Traverse Table. Pl. II. Fig. 62.

N.	Courses	dist.	P.	Latitude N.	Latitude S.	Departure E.	Departure W
1	West.	23	4				2.3
2	N. E.	26	4	18.4			
3	North	8	4				
4	West	16	4				16.
5	North	50	4	20.5			
6	N. E.	29	4			20.5	
7	S. E.	50	4		20.5	20.5	
8	South	16	4		8		
9	West	8	4		18.4		
10	South	26	4				18.4
11	S. E.	8	4			18.4	
12	West	23	4				2.3
13	North	75	4	75			
14	S. E.	7	4			4.9	
15	S. W.	6	4		4.9		
16	S. E.	50	4		35.4	35.4	
17	N. E.	14	4	9.9		9.9	
18	N. W.	50	4	35.1			
19	S. W.	6	4		4.2		
20	N. W.	7	4	4.9			
21	N. E.	7	4			4.9	
22	S. E.	6	4			4.2	
23	N. E.	50	4	35.4		35.4	

N.	Courses	dist.	P.	N.	S.	E.	W
26	N. W.	14	4	9.9			9.9
27	S. S. W.	50	4		35.4		35.4
28	S. E.	6	4		4.2		4.9
29	S. W.	7	4		4.9		4.9
30	N. N. E.	6	4	4.2		4.2	
31	N. W.	50	4	35.4			
32	S. S. W.	14	4		9.9		9.9
33	S. E.	50	4		35.4		35.4
34	N. E.	6	4	4.2		4.2	
35	S. W.	7	4		4.9		4.9
36	N. W.	6	4	4.2			4.2
37	S	50	4		35.5		35.5
38	S. E.	14	4		9.9		9.9
39	N. E.	50	4	35.4		35.4	
40	N. W.	6	4	4.2			4.2
41	N. E.	7	4	4.9		4.9	

By fuming up the northings, southings, eastings, and westings; we find the × of latitude, and departure = 00.

Queſtion 5th. Suppoſe a ſhip ſails from a certain road in latitude 55 deg. 33 min. north, and meeting with contrary winds, ſails theſe ſeveral courſes following, viz. N. W. by N. 40 miles, Eaſt 15, N. E. 30, S. E, 10, S. W. 10, N. W. 30, N. E. 10, S. E. 10, S. W. 30, N. W. 10, N. E. 10, S. E. 30, Eaſt 15, S. W. by S. 40, N. E by E. 40, South 15, S. E. 30, S. W. 10, N. W, 10, N E. 30, S. E. 10, S. W. 10, N. W. 30, N. E. 10, S. E. 10, S. W. 30, South 15, N. W. by W. 40, S.E. byS 40, Weſt 15, S.W. 30, N.W. 10, N.E. 10, S.E. 30, S. E. 30, S. W. 10, N. W. 10, N. E. 30, S. E. 10, S. W. 10, N. W. 30, Weſt. 15, N. E. by N. 40, S. W. by W. 40, North 15, N. W. 30, N. E. 10, S. E. 10, S. W. 30, N. W. 10, N. E. 10, S. E. 30, S. W. 10, N.W. 10, N. E. 30, N. 15, S. E by E. 40 miles? I demand her courſe and diſtance made good, difference of latitude and departure, with latitude come to. *Pl.* II. *Fig.* 63.

I thought to have propoſed ſeveral curious traverſe queſtions here, but muſt refer them to the appendix.

MERCATOR SAILING.

MERCATOR ſailing is projected in a right angled triangle, as plain ſailing, only the triangle hath two perpendiculars, the ſhorter repreſenting the departure as in plain ſailing, and the longer is the difference of longitude.

Then in the triangle A D E, A repreſents the place ſailed from, the angle at A, is the courſe, and A B, is the proper difference of latitude, and B C the departure, as in plain ſailing, the whole baſe A D, is the meridional difference of latitude, and D E the difference of longitude, and ſeeing the angle at A, is common to both triangles A B C, and A D E, therefore the baſe A B is in proportion to the perpendicular B C, is the whole baſe A D is to the perpendicular D E, hence comes the proportion, as the proper × of latitude is to the meridional × of latitude, ſo is the departure or difference of meridians, to the difference of longitude.

The meridian line, with ſcale of equal parts, next to it upon the ſcale, are of uſe in laying down queſtions; in mercator ſailing they are the two loweſt lines on the ſcale, the meridean line marked (merid.) and the equal parts (Eq. p.) the graduation of the meridean line increaſes and the degrees of latitude grow bigger near the poles, the diſtance and proper × of latitude may be taken of the equal parts, and

and the meridan ✕ of latitude of the meridian line if the queſtion be ſo large as to permit. Nevertheleſs in ſmall queſtions, and ſhort diſtances, where the diſtance between the two latitudes upon the meridian line is too little to make a handſome figure, you may find the meridional difference of latitude by the table of meridional parts, and ſo take both it and the proper ✕ of latitude, with the diſtance, departure, and difference of longitude of any equal parts you think will be proportional, to the demenſions that you would have your Queſtion to contain; only take care that from whatſoever equal parts, you take the given ſides, you muſt meaſure the required ſides, when found upon the ſame equal parts.

The Uſe of the TABLE *of meridional Parts.*

In finding the meridional difference of latitude, you are to obſerve, if two places (whoſe meridianal difference of latitude you ſeek) be both in north latitude or both in ſouth latitude; ſubſtract the meridianal parts of the leſſer latitude from the meridional parts of the greater latitude, the remainder is the meridianal difference of latitude; but if one be in north and the other in ſouth, add the meridianal parts of both latitudes together, the ſum is the meridial ✕ of latitudes.

A general Rule for working MERCATOR SAILING *Arithmetically.*

When you have wrought the two proportions by plain ſailing, Arithmetically by natural lines, and then for difference of longitude, as proper difference of latitude is to the meridianal difference of latitude, ſo is the departure or difference of meridians to the ✕ of longitude.

Caſe 1ſt. Both Latitiudes and Longitudes of two Places being given to find the Courſe, Diſtance, and difference of Meridians.

Suppoſe a ſhip ſails from Cape Clear in latitude 51 .10 North, and longitude 10 .30 Weſt, to Cape Henry in latitude 37 .00 North, and longitude 74 .30; Required her courſe, diſtance and ✕ of meridians?

Latitude	51 .10	M P	3585	prop. ✕ lat.	14 .10	Long.	74 .30
Latitude	37 .00	M P	2393		60	Long.	10 .30
	14. 10		3)1192		3)850		64 00
			397	L.	71. 283		60
							3)3590
							1280

The Geometrical Projection. Pl. II. *Fig.* 65.

Draw D C for the meridian of Cape Clear, and on it from C, ſet off

off the meridianal ✕ of latitude 397 leagues from L to D, then erect a perpendicular from D towards Q, and ſet on it from D, the difference of longitude 1280 parts to Q, and draw the lines D Q and C Q, from the ſame line of equal parts you took C D from, take 283 the proper ✕ of latitude, and ſet it from C to S, and draw the line S A parallel to the ✕ of longitude D Q, with the chord of 60 in the point C, deſcribe an arch c q, which meaſured on the line of chords gives 72 .46 for the courſe from Cape Clear to Cape Henry.

Explanation. C repreſents cape Clear, A cape Henry, C A the diſtance S A, the ✕ of meridian, c q or ∠ at C, the courſe S. weſterly from cape Clear to cape Henry. C A and S A, meaſured on the equal parts ſeverally, gives 955.2 leagues for the diſtance, and 912.3 leagues for the departure.

Trigonomitrically.

As M. ✕ of lat.	397	2.51879	
Is to tangent ra.	45 :00	10.00000	
So is ✕ longi.	12 50	3.10721	
To tagent courſe	72 46	10.50842	
As S. C. courſe	17 14	9.411678	
Is to P. ✕ of lat.	283	2.451786	
So is Radius	90 00	10.000000	
To the diſtance	95 52	2.980108	
As Radius	90 00	10.000000	
Is to the diſtance	955.2	2.980108	
So is fi. courſe	72 46	9.980052	
To the ✕ of mer.	512.3	2.060153	

Arithmetically.

As m. ✕ of latitude is to ✕ of longitude : : proper ✕ of latitude to ✕ of meridian

397 : 1280 : : 283

233

3830
10840
2560

397)362240(91 .24912.3
3573

494
397

976
784

1760
1588

Then (P. 47. E) 912.3 912.3 — 283 283

27369
18246
9123
52107

849
2364
590

80089 Sq. P. ✕ lat.

Sq. of difference mer. 832291.29

Then 832291.29 + 80089 = 912380.29 = Z ſquares. Whoſe ſquare Root is 955.2 leagues, the diſtance as before.

Inſtru-

Inſtrumentally.

The extent from 397 to 1280 on the numbers laid from tan. 45 00 gives tangent 72. 46 on the tangents for the courſe.

2d. The extent from ſi. 17 14 to ſi. 90 00 on the ſines laid from 283, gives 9 .5 on the numbers for the diſtance.

3d. The extent from radius or ſine 90 .00 to ſine 72 46 being laid from 955.2, gives 912.3 on the line of numbers for the difference of meridians as was required.

Example II. Suppoſe a ſhip takes her departure from the Lizard, in latitude 49 55 north, and longitude 5 29 weſt, being bound to Antigua in latitude 17 15 north, and longitude 61 44 weſt, what courſe muſt ſhe keep, and what diſtance and ✕ of meridians make to the ſaid iſland?

Lizard latitude	49 55	M. P.	2 67	Longitude Lizard	5 23 W
Antigua lat.	17 15	M. P.	1071	Longitude Antigua	61 44 W
Remains	32 40		3)2404		56 21
	60			✕ of long.	60
	3)1960 = P. ✕ lat.		805 leagues		3381
	653 leagues			leagues	1127

Draw L E the meridian of the Lizard, on which ſet of the meridian ✕ of latitude 805, from L to E, and erect the perpendicular E Q. on which ſet off the ✕ of longitude 1127 leagues, from E to Q, and draw the line Q L, again ſet off the proper ✕ of latitude 65 from L to S, and draw the line A S, parallel to the ✕ of longitude E Q, then L, repreſents the Lizard, A Antigua, S A the departure, L A the diſtance, the arch c q the courſe S weſterly from Lizard to Antigua.

L A and S A, meaſured on the equal parts ſeverally, gives 1127 for the diſtance, and 912 for the departure, and the arch c q meaſured on the chords gives S. 54 28 Weſt.

Trigonometry.

As M. ✕ of latitude	805	2.905776
Is to Tangent Radius	45 .00	10.000000
So is ✕ of longitude	1127	3.051924
To tangent courſe	54 28	10.146148

As

Trigonometrically.

As fine C. co 35 .32		9.764308
Is to P. × lat. 653		2.814913
So is radius 90	00	10.000000
To the diſtance 11	24	3.050605
As radius 90	00	10.000000
Is to the diſtance 1124		3.050605
So is fine courſe 54	28	9.910033
To the × mer. 914.4		2.961111

Arithmetically.

m. ×s. × lon. × lat.

As 805 : 1127 : : 653 : $\frac{1127 \times 653}{805} = 914.2 =$ the departure or × of mer.

914.2 × 914.2 = 835761.64

653 × 653 = 426409

1261770.6

Whoſe ſquare Root is = 1123 the diſtance.

The courſe is found by dividing the × of mer. by the diſt. 1124) 914.2000 quotes .8135 the nat. ſi. of 54.28 the courſe required.

Inſtrumentally.

The extent of 805 to 1127 on the line of numbers laid on the tangent from 45 .00 gives tangent 54 .28 the courſe. Then the extent from ſi. co. courſe 35 .32 to radius on the lines being laid from 653 on the numbers, gives 1124 the diſtance. Lastly the extent from radius or ſine 90 on the line, to ſine 54.28, the line courſe being laid from 1124 on the numbers gives 914.2 the × of meridians required.

Caſe 2d. Both latitudes and courſe being given to find the diſtance × of meridians and × of longitudes.

Suppoſe a ſhip ſailed N. W. half W. from a certain road in latitude 50 .51 north, and longitude 31 . 7 eaſt, till by obſervation ſhe is found in latitude 57 .33 north, I demand her diſtance, × of meridians, × of longitude and longitude come to?

Latitude	57 .33	
Latitude	50 51	
	6 42	M. P. 4244
	60	M. P. 3555
	3)402	3)689
P. × lat.	134	M. × l. 229 $\frac{2}{3}$

The

The Geometrical Projection. Pl. II. *Fig.* 66.

Conſtruct the triangle A B C, by the courſe and × of latitude according to the ſecond caſe in plain ſailing; make A C, = the mer. × of latitude = 227 legues, and draw E C = the × of longitude parallel to D B the departure till it meet the diſtance A D produced in E, then is A D the diſtance ſailed = 211.3 leagues, and C E = 276.7 = the × of longitude, and B D = 163.4 leagues.

Trigonometrically.

As ſi. C. courſe	39 .22	9 802282
Is to × lat	134	2.121105
So is radius	90 .00	10.
To the diſtauce	211.3	2.324825
As radius	90 .00	10.
Is to the diſt.	211 3	2.324823
So is ſi. courſe	30 .38	9.888237
To the depar.	163.4	2.213060
As tan. radius	45 .00	10.
Is to mer. × lat.	227.	2.356026
So is tan. cou.	50 .38	10.095956
To × lon.	276.7	2.441983

Arithmetically.

Natural Sines 39.22 = .6341
Natural Sines 50 38 = .7731

.6343 : 134 : : 1 :

6343)134.0000(211.3 hence the diſtance = 211.3 leagues.

1 : 211.3 : .7731

211.2 × 7731 = .163.4

Hence meridional diſtance 173.4 Leagues.

$$134 : 163.4 : 227 \quad \frac{163.4 \times 227}{134} = 276.7 \text{ the } \times \text{ of longitude.}$$

276.7
3
6)830.1
13 .50

Long. depar. 31 .37
× of long. 13 .50
Long. come to 17 .47

anſwer	leagues
Diſtance	211.3
× of meridian	163.4
× of longitude	276.7

The Anſwer.

Inſtrumtneally.

The extent from ſi. 39 .22 to ſi 90 .00 laid from 134 on the line of numbers to the right hand, gives 211 3 the diſtance. Then the extent from ſi. 90 .00 to ſine 50 38 laid from 211.3 on the line of numbers to the left hand gives 164.4 for the difference of meridians laſtly the extent from tangent 45 00 to tangent 50 38 laid from 227 the meridian diff. of latitude on the line of numbers to the right hand gives 276.7 the diff. of longitude required.

Case 3d. *Both Latitudes and Distance being given to find the Course, difference of Meridians and difference of Longitude.*

Sailing in the S. E quarter, from the latitude 57 .59 North, and longitude 8 50 E making our distance 266 leagues, and by observation we were in latitude 49 .53 North; required our course, × of meridians, × of longitude and longitude come to?

Latitude 57 .59	M. P. 4292	P. × lat. 162
Latitude 49 53	M. P. 3464	M. × lat. 276 lea.
8 06	3)828	
60		
	lea. 276	
3)486(162 lea.		

The Geometrical Projection. Pl. II *Fig.* 67.

With the difference of latitude 162 = parts, and distance 276 = parts, project the triangle A B C, by case the fourth of Plain Sailing.

Let A C be made = 276 the meridional × of latitude, and erect the perpendicular C E, till it meet A D, continued in E; then is B D equal the × of meridians = 211 leagues, and C E, = 359.5 leagues, the × of longitude being measured on the scale of equal parts gives 359.5, also the ∠ B A D the course, the arch of which ∠ on the chords is = 52 .20.

Trigonometrically.

As the distance	266	2.424882
Is to Radius	90 .00	10.000000
So is P. × Lat.	162	2.209515
To S. C. co.	37 .31	9.784633
As Radius	90 .00	10.000000
Is to the dist.	266	2.424882
So is S. course	52 .29	9.899370
To the × of mer.	211	2.324252
As tan. Radius	45 .00	10.000000
Is to M. × lat	276	2.440909
So is tan. cou.	52 .29	10.114758
To × of long.	359.5	2.505667

Arithmetically.

$266 : 1 :: 162 : \frac{162}{266}$.

266) 162.0000(.609 =
N. S. 37 31. Sine Com. Course =
52 .29 N. S. .7932

1 : 266 : : 7932 : 211 = departure.

162 : 276 : : 211 : $\frac{276 \times 211}{162}$ = 359.5 = × of longitude.

$\frac{359.5 \times 3}{60}$ = 19 .38 E.

Longitude departure 8 .17 E.

Longitude come to 27 .55 E.

Instru-

Inſtrumentally.

The extent from 266 to 162 on the line of numbers laid from S. 90 .00 gives S. 37 .31 = S. com. courſe; then 90 .00 — 37 .31 = 52 .29 ſi co. Then the extent from ſi. 90 .00 to ſine 52 .29 on the ſines laid from 266 on the the line of numbers to the left hand gives 211 for the departure. Laſtly extend from T. 45 to T. 52 .29, being laid from 276 on the numbers, will give 359 5 the × of longitude required.

Caſe 4th. Both Latitudes and difference of Meridian being given to find the Courſe, Diſtance, and × of Longitude

Suppoſe a ſhip ſails from a certain road in latitude 57 .19 north, and longitude 22 .17 eaſt, in the S. W. quarter till by obſervation ſhe is in latitude 49 .05 north, making her × of meridians 188 leagues; I demand her courſe, diſtance, × of longitude, and longitude come to?

Latitude 57 .19 N.	M. P. 4218	Prop. × of latitude 165
Latitude 49 .05 N.	M. P. 3390	Meridian × of lat. 276
5 14	3)828	
60	276	
3)494(165 neareſt		

Geometrical Projection. Pl. II. Fig. 68.

Draw the meridian line A B, on which ſet off the proper × of latitude from A to B, and the meridianal × of latitude from A to C, from the point B and C, erect the perpendiculars B D and C E, upon B D ſet of the departure 188 from B to D, and through the point D, draw the line A D E, and the projection is done.

Then the ∠ A, meaſured on the chords is 48 .44 for the courſe which is S. W. half W. and the diſtance A D, is 250 leagues and the perpendicular E C is 314.5 the × of longitude required.

Trigonomitrically.

As pr. × of lat.	165	2.217483
Is to tangent ra.	45 .00	10.000000
So is × meridian	188	2.274157
To tan. courſe	48 .46	10.056674

Arithmetically.

By 47 E. 1ſt. the ſquare root of the ſum of the ſquare of the difference of latitude and departure, gives the diſtance.

Trigo-

Trigonometrically.

As S. course	48 .46	9.376014
Is to P. × mer.	18 8	2.274157
So is Radius	90 00	10.000000
To the distance	250	2.398143
As tan Radius	45 .00	10.000000
Is to mer. × lat.	276	2.440969
So is T. course	48 .46	10.056674
To the × of lon.	316.5	2.497643

Hence dif. of long. is 316.5 leag.

Arithmetically.

That is $\sqrt{165^2 + 188^2} =$ 250 leagues, the distance sailed.

Then 250 : 1 : : 188

250)188.0000(.7520 =

Natural line 48 .46 the course from south to the westward or S. W. half W. nearest.

Lastly 165 : 188 : : 276

$\frac{188 \times 276}{165} = 316.7$ the × lon.

Instrumentally.

The extent from 165 to 188 on the line of numbers laid from tangent 45 .00 gives tangent 48 .46 the course. Then the extent from line 48 .46 to line 90 .00 being laid from 188 in the line of numbers to the right hand gives 250 the distance. Lastly the extent from tangent 45 .00 to tangent 48 .44 this laid from 376 the meridian difference of latitude on the numbers gives 316.5. = × of long.

diff. of longitude	15 .49 W.
Longitude departed	22 .17 E.
Longitude come to	6 .28 E.

Then $\frac{316.5 \times 3}{60} = 15$ .49 W.

Longitude come to 6 .28 E.

As was required.

Case 5th. One Latitude, Course, and Distance being given to find the difference of Latitude, diff. of Meridians, and diff. of Longitude.

Suppose a ship sails S E. by S. thee quarters E. from a certain port in latitude 57 .57 north, and longitude 22 .51 W. making her distance by the log 279 leagues; I now demand her diff. of latitude, diff. of meridian, diff of longitude, and latitude, and longitude come to?

The Geometrical Construction. Pl II. *Fig.* 69.

Draw the meridian line A B C at pleasure, and make the ∠ B A D = 42 .11 the ships course, and draw A C continued; upon which, from the equal parts, set of the distance 279 leagues, from A to D, let fall the perpendicular B D, (having set of the meridian diff. of latitude 344 from A to C) and draw the line C E, and the work is done.

Then

Then is A B = 206.8 the difference of latitude, and B D = 187.4 leagues, the diff. of meridians and C E = 311.7 the diff. of longitude, as was required.

206.8	Lat. dep.	57 .57 N.	Lat.	57 .57	M. P.	423.9
3	× lat.	10 20 S.	Lat.	47 37	M. P.	3257
60)6204	La. come to	47 37 N.				3)1032
10 .00				M × of latitude		344

Trigonometrically.

As radius	90 .00	10.000000
Is to the distance	279	2.445624
So is fine co.	42 11	9.827018
To the × mer.	187.4	2.272642
As radius	90 00	10.000000
Is to the distance	279	2 445607
So is fi. co. cou.	47 .49	9 869818
To the × lat.	206.8	2.315425
As tang. radius	45 .00	10.000000
Is to mer. × lat.	344	2.536558
So is tan. course	42 .11	9.957231
To the × lon.	311.7	2.493789

Arithmetically.

Natural fine 42 .11 = .6713
Natural fine 47 .49 = 741

279 × 6713 = 187.32
279 × 741 = 2068

hence difference of latitude is 206.8 leagues
× of meridians 187.4 lea.

To find the difference of longitude.

206.8 : 187.4 : : 344 $\frac{187 \times 4}{206}$

311.7 as was required.

311.7		60)935(15	.35	East
3	long.	depar 22	15	West
9351		lon. come to 7	16	West

Instrumentally.

The extent from fine 90 .00 to fine 42 .11 laid from the distance 279 on the numbers gives 187.4 the departure. The extent from fine 90 00 to fine 47 .49 laid from 279 on the numbers gives 206.8 × of latitude.

Lastly the extent from tangent 45 00 to tangent 42 11 being laid from 344 the meridian difference of latitude on the line of numbers gives 311.7 leagues the difference of longitude required.

Case

Case 6th. One Latitude, Course, and difference of Meridians, being given to find the distance, difference of Latitude and difference of Longitude.

Suppose a ship sails from a certain road N. W. by W. from the latitude 43 .51 north, and longitude 45 45 E, and makes her difference of meridians 177 miles; I demand her distance, difference of latitude, difference of longitude, and latitude, and longitude come to.

Geometrical Construction. Pl. II. *Fig.* 70.

Draw A B C, the meridian at pleasure, at an angle of 56 .15 draw the line A D E continued at 177 distant from the meridian, draw a parallel D g, and where it cuts A D C as in D, let fall the perpendicular D B, then is A B the proper difference of latitude by which you may find the latitude come to, and also the meridian difference of latitude, draw the perpendicular C E, to cut A E, in E, and it is done, the latitude come to is 45 .49 the difference of longitude C E = 250.

Trigonometically.

As sine course	56 .15	9.919846
Is to the departure	177	2.247971
So is radius	90 00	10.
To the distance	212.9	2.328127
As radius	90 00	10.
Is to the distance	212.9	2.328127
So is sine C course	33 45	9.744739
To the × latitude	118	3.872806
As tan. radius	45 00	10.
Is to mer. diff. lat.	167	2.222716
So is tan. course	56 .15	10. 175107
To the diff. long.	250	2.397823

Arithmetically

Natural sines 56 15 = .8315
Natural sines 33 45 = .5556

8315 : 177 : : 1
8315(177. 000(21?.9
hence 212.9 — distance

Then 212.9 × .5556 = 118 the distance.

Again,

118 : 177 : : 167 :

$\frac{177 \times 167}{118}$ = 250 the difference of longitude

$\frac{118}{60}$ = 1 58N

Lat. departed	43	51N
Latitude ship	45	49N

M. P. 3100
M. P. 2933

M. × lat. 167

Diff. of long.	4	10 W
Long. dep.	45	45 E
Long. come to	41	35 W

Instrumentally

Inſtrumentally.

The extent from ſine 56 15 to ſine 90 00 being laid from 177 the dep. on the line of numbers to the right hand, gives 213 neareſt for the diſtance. Secondly, the extent from ſine 90 00 to 33 45 laid from 213 on the line of numbers to the left hand gives 118 for the P. difference of latitude. Laſtly the extent from tangent 45 00 to tangent 56 15 being laid from 167 on the line of numbers to the right hand, gives 250 the diff. of longitude required.

Caſe 7th. One Latitude, Diſtance and difference of Meridians, being given to find the Courſe, difference of Latitude, and diff. of Longitude

Suppoſe a ſhip ſails in the N. E. quarter from the latitude 51 17 North, and longitude 27 21 Weſt, making her diſtance 289 leagues, and her difference of meridean 217 leagues; I demand her courſe, diff. of latitude, diff. of longitude, and latitude and long. come to?

The Geometrical Conſtruction. Pl. II. Fig. 71

Draw the meridian A B C, at pleaſure, at the diſtance of 217 the difference of meridians, from A B C draw the parallel; then with the diſtance 289 and one foot in A, croſe the ſaid parallel *e g* in D, let fall the perpendicular B D to cut A B C in B, then is A B the proper diference of latitude, by which find the meridean difference of latitude, as in the laſt caſe, which ſet from A to C, and raiſe the perpendicular C E, from A, through the croſſing at D draw A D E, to cut C E in E, and it is done.

Trigonometrically.

As the diſtance	289	2.460818
Is to radius	90 00	10.
So is × merid.	217	2.336460
To the ſine cou.	48 40	9.875562
As radius	90 00	10
Is to the diſtance	289	2.460898
So is ſi. co. cou.	41 20	9.819822
To the × of lat.	190.9	2.280730
As tangent rad.	45 00	10.
Is to mer. × lat.	344	2.536558
So is tan. cour.	48 40	10.055778
To the dif. of lon.	391	2.592296

Arithmetically.

To find the courſe

289 : 1 : : 217 : $\frac{217}{289}$ = .7508 = natural ſines 48 48.

To find the P. diff. of latitude

By 47. E. 1 the ſquare root of the diff. of the ſquares of the diſtance and departure, gives the diff. of latitude.

That is $\sqrt{289^2 - 217^2}$ = 191 very near.

Mer.

Lat. departed	51 .17N	Lat. 60 .50	M. P. 4629	P. × lat.	191
diff. of lat.	9 .6N	Lat. 51 17	M. P. 3593		3
Lat. come to	60 50N	Mer. × of Lat.	1033	60)573(9.33	

To find the difference of Longitude Arithmetically.

Say, 191 : 344 : 217 :

$\frac{344 \times 217}{191} = 391 =$ diff. long.

$\frac{391 \times 3}{60} = 19 .33$ East

Longitude departed	19 .33	E
diff. of Longitude	27 31	W
Longitude come to	7 50	W

Inſtrumentally.

The extent from 259 to 217 on the line of numbers, beings laid from fine 90 .00 gives fine 48 .40 = the courſe N. E. half E.

Secondly, the extent from fine 90 .00 to fine 41 20 on the fines laid from 289 the diſtance on the numbers gives 191 the difference of Latitude. Laſtly, the the extent from tangent 45 00 to tangent 48 40 being laid from 344 on the line of numbers, gives 391 the difference of longitude

Caſe 8th. One Latitude, Courſe, and difference of Longitude being given to find the Diſtance, difference of Latitude and diff. of Merideans.

Suppoſe a ſhip ſail S. W. half W. from a certain road in latitude 55 .31 North and Longitude 29.55 Eaſt to the longitude 13 .18 Eaſt; I demand her diſtance, difference of latitude, difference of meridians, and latitude come to?

The Geometrical Conſtruction.

Draw the meridian A B C at pleaſure, make the ∠ B A C = four points and three quarters or 53 26 draw the hypothenuſe A D continued; at the diſtance of 332 leagues the × of longitude, draw the line F E parallels to A C, from that point where that parrallel interſect the hypothenuſe continued at E, let fall the perpendicular E C, Set off the proper difference of latitude 152 leagues from A to B, and draw the line B D parallel to the difference of longitude E C and the conſtruction is done; then is A B the proper difference of latitude = 457 which reduced into degrees and min. is 7 .37 which ſubtracted from the latitude ſailed from, (viz.) 55 31 the remainder is 47 54 the latitude come to, and A D is 767 miles the diſtance required.

From	90 .00	Long.	29 55 E.	16 37	
Sub.	53 26		23 18 E.	60	
Rem.	36 34		16 37 E.	991	× of Longitude.

Trigono-

Trigonometrically.

As tang. courſe	53 .26	10.129735
Is to × long	997	2.998695
So is tan. radius	45.00	10.
To mer. dif. lat.	739	2.868960
As ſi. co. courſe	36 .34	9.775070
Is to P. × of lat.	474	2.659916
So is radius	90 .00	10.
To the diſt.	767	2.884846

For the difference of meridians.

As radius	90 .00	10.
Is to the diſtance	767	2.884846
So is S. courſe	53 .26	9.904804
To the × mer.	616	2.789650

Lat.	55 .31	M. P. 4022
Mer. × of latitude		739
Latititude	47 .54	3283

× lat. 7 .37
60

457 × of latitude

Note the M. P. 3283 being found in the table, ſhews the latitude 47 .54

Anſwer in Miles,

Diſtance	767
Difference of latitude	457
Difference of merid.	616
Latitude come to	47 .54 N.

Arithmetically.

Natural Sine 53.26 = .8032
Natural Sine 36.34 = .5957

To find the meridian × of lat.

Natural tangent 53 .26 = 1.348
Then 1.348 : 997 :: 1 : $\frac{997}{1.348}$
= 739 the mer. × of latitude.

To find the diſtance

.5957 :: 457 :: 1 : $\frac{457}{.5957}$

5957) 457.000 (767 the diſtance

To find the × of Meridians

1 : .767 :: .8032 : 616,

That is .8032 × 767 = 616 the × of meridians, the ſame as before.

Inſtrumentally.

The extent from Tangent 53 .26 to tangent 45 00 laid from 997 the diff. of longitude on the line of numbers gives 739 the meridian difference of latitude.

Secondly, The extent from ſine 36 .34 to ſine 90 .00, that extent laid from 457, the proper diff. of latitude on the line of numbers, gives 767 the diſtance.

Laſtly, Extend from ſine 90 .00 to ſine 53 .26, that extent laid from 767 the diſtance on the line of numbers will give 616 the difference of meridians required,

Case 9th. One Latitude, Distance and difference of Longitude being given, to find the Course, difference of Latitude, and diff. of Meridian.

Suppose a ship in latitude 50 .00 N. sails in the S. W. quarter 100 miles, having no compass on board that was good, but knowing her distance by log was 52 miles less than her meridional distance, and longitude departed from 5 .29 West; I demand her course, × of latitude, × of meridians, and latitude and longitude come to; Our × of longitude being 85 miles?

The Geometrical Construction. Pl. II, *Fig.* 74

Draw the meridian A B C, as before directed, and parrallel to it at 85 miles (the × of longitude) distant, draw the line E F, then with the extent of 152, the mercatoral distance, and one foot in A, with the other cut the parallel aforesaid in E, and draw the line A E and set off 100 miles from A to D and draw B D parallel to C E, then is A B the proper × of latitude, A D the distance run by the log; C E the × of long. A E the mercatoral dist. and ∠ B A D the course steered,

Trigonometrically.

As mercat. dist.	152	2.181844
Is to radius	90 00	10.
So is × long.	85	1.929419
To fine cou.	34 00	9.747575
As radius	90 00	10.
Is to the distance	100	2.000000
So is fi. co. cou.	56 00	9.918574
To the × of lat.	82.9	.1918574

To find the × of meridians

As radius	90 .00	10.
Is to distance	100	2.000000
So is fine cour.	34 .00	9.747575
To the × mer.	55 .92	1.747575

Or rather 56 miles.

Arithmetically.

To find the course

1528 : 1 :: 85 : 1528)85.000
(.5592 = natural fine 34 .00

N. S. 56 .00 = .829 Then 100 × .829 = 82.9 or 83 the × of latitude.

To find the diff. of meridean

Natural fine 34 .00 = 5592 Then .55.92 × 100 = 5592 or 56 miles, the difference of meridians.

Instrumentally.

The extent from 152 the mercatoral distance to 85 the difference of longitude on the line of numbers laid from fine 90 .00 gives 34. 00 for the course S. Westerly or S. W. by S. nearly.

To

To find the difference of Latitude.

The extent from fine 90 .00 to fine 56 .00 (the Sine Com. Courſe) being laid from 100 on the line of numbers, gives 32.9 or 33 the × of latitude required.

To find the difference of Meridians.

The extent from fine 90 .00 to S. 34 .00 (the S. Courſe) being laid from 100 the diſtance on the line of numbers gives 55 92 or 56 the × of meridian required.

MERCATORS TRAVERS.

ADMIT a ſhip from the latitude of the Lizard 49 .55 North, and longitude 5 .23 Weſt, is bound to Madera in latitude 32 .23 N. and longitude 17 45 Weſt, runs theſe courſes; (viz.) S. S. W. 70 leagues, S. W. by W. 80 leagues, W. by S. 90 leagues, W. S. W. 100 leagues; I demand the bearings and diſtance of the Lizard and Madera; and alſo the courſe and diſtance made good, with the latitude and longitude the ſhip is in, likewiſe the bearings and diſtance from the Lizard and Madera to the ſhip at the end of her traverſe.

PREPARATION.

Latitudes	49 .55 N 32 25 N	M. P.	3467 2058	Longitudes	5 .23 W. 17 42 W.
	17 30 20		3)1409		12 .19 20
	M. × lat. 469 lea.				

P. × of Lat. 350 lea. × of Lon. in lea. 246 W.

The courſe from the Lizard to Madera is 27 .38 Weſterly, diſtance 395 leagues, departure 184 leagues found by caſe 1ſt.

With theſe given things protract the mercator triangle L D Q, by caſe 1ſt. of mercator ſailing, ſo ſhall L repreſent the Lizard, and M Madera.

Project your traverſe with the given courſes, and diſtances as directed in the firſt caſe of plain ſailing traverſe, aforegoing; and the ſhip will be found at the point T.

Draw T R, the meridian of the ſhip, parallel to the meridian of the Lizard L D, till it meet with the parallel of latitude of Madera S M, in R, and draw T M; ſo ſhall T R, be the × of latitude or ſouthing, R M the departure or eaſting, and T M, the diſtance the ſhip hath to make the iſland Madera.

To

SOLUTION, *By the Traverſe Table.*

Courſes	Diſt.	Pts.	× lat	Lati.	ↄ W	× L.	long.
S. S. W.	70	2	64.7	46.41	26.5	40.00	7.23
S W. by W.	80	5	44.9	44.28	66.5	94.00	12.05
W. by S.	90	7	17.6	43.35	88.3	124.0	18.17
W. S. W.	100	6	38.3	41.40	92.4	125.0	24.32

Difference of Latitude 165.0 dep 274.0 × lon. 383.

I ſhall omit the inveſtigation of the ſeveral differences of longitude in the table above for brevity ſake, and leave it to the diligent ſtudent; the diff. of latitude made good is 165 leagues, and the departure 274 leagues the ſhip hath made good; then by caſe 6th. of plain ſailing, the courſe is found — S. 59 .00 Weſterly, and the diſtance 320 leag. the latitude the ſhip is in, 41 .40 N. and longitude 24 .32 W. the difference of latitude in meridional parts; between the latitude 49 .55 and the ſhip, is 237 leagues, which ſet from L to P, and draw N P, which is the whole difference of longitude the ſhip hath made = 383 leagues, parallel to T V, till it meet L T produced in N. Again, the meridional difference of latitude between 41 40, and Madera 32 .25 is 232 leagues, which ſet off from T to m, and draw the difference of longitude to Madera m n, as before directed, and the ſcheme is finiſhed.

Laſtly to find the courſe, bearing, diſtance, and eaſting, the ſhip muſt make to her intended port Madera, by caſe 1ſt. of mercator ſailing, thus,

Lat. { Ship 41 .40 / Madera 32 25 } = 9 15 = 20 M. × lat. 232 lea.

M. P. { 2755 / 2058 } = 3)697

Longitude { 24 .32 Weſt / 17 42 Weſt } = 6 50 East = 20

× of latitude 183 leag. × of long. 137 lea.

Then ſay,

As M. × lat. 232 : T. R. 45 .00 : : × long. 137 : T. C. 30 .34

As S. C. C. 59 .26 : pro. × lat. 185 : : R. 90 .00 : : diſt. 215 lea.

As Radius 90 .00 : diſt. 215 : : S. C. 30 .34 : : × of mer. 209 lea.

There-

Therefore Madera bears from the Lizard S. 27 .38 Weſt or near S. S. W. half W. diſtant 305 leagues, departure 184 leagues.

The Lizard bears from the ſhip N. 58 .57 Eaſterly, or near N. E. by E. quarter E. diſtance 395 leagues, departure 274 leagues, Madera bears from the ſhip S. 30 .34 Eaſterly, diſtance 215 leagues, departure or eaſting to Madera is 109 leagues Q E I.

To Project the Mercator's Chart, for all, or part of the Globe's Superfices.

FOR the general chart, it is projected upon a plain, the meridians being parallel to each other (which on the globe do incline and meet in the poles) yet the parallels are contrived ſo at an unequal diſtances, that in this projection the rhumbs are right lines, and the degrees of longitude bears the ſame proportion, to the degrees of latitude in any parallel, that they do upon the Globe; now to make a chart to repreſent one half of the ſuperfice of the Globe or near it, for you cannot go quite to the poles by reaſon that one degree of latitude there, in quantity, is infinite; you make uſe of the meridian line, with the line of equal parts; the two loweſt lines, upon Gunter's ſcales.

Having provided a large ſheet of paper almoſt as broad as long (viz. the breath to contain the 180 equal parts, anext to the meridian line on the ſaid ſcale) draw a line croſs the middle of it, that may contain 180 parts from the ſcale; this line ſo graduated, ſhall repreſent the equinoctial, and the diviſions 180 degrees of longitude; draw lines along each edge of the equinoctial perpendicular to it, and theſe lines being graduated upwards and downwards from the ſaid equinoctial, by the diviſion of the meridional line, to about 85 degrees of latitude on each ſide of the equinoctial. Then draw lines through every 10 degrees of thoſe unequal diviſions parallel to the equinoctial; and likewiſe draw lines through each 10 degrees of the equinoctial and perpendicular to it; ſo will theſe meridians laſt drawn, interſect the parallels firſt drawn in every 10 degrees of latitude and longitude.

Then at each corner of your chart, you may deſcribe an arch or quadrant, and divide it into 8 equal parts; and drawing from the center rhumb lines through the chart, noting the north point of the ſaid quarter with the flower deluce.

And laſtly to lay down any iſland, headland, or given place, whoſe latitude and longitude is known by obſervation, or approved tables of latitude

latitude and longitude; Take a pair of compaſſes, and with one foot in the latitude of the place on the graduated meridian, extend the other foot to the neareſt parallel, or eaſt and weſt line, and there let them remain; then with another pair of compaſſes and one foot in the longitude of the place upon the equinoctial, extend the other to the neareſt meridian, (or north and ſouth line) then running each pair of compaſſes along their reſpective lines towards each other, the moveable points will meet in the given longitude and latitude, or point where the place given is to be laid down; and by two ſuch charts as theſe (which together make a ſquare) you may repreſent all the ſuperfices of the earth, except five degrees of latitude under each pole.

To make a Chart for a particular Voyage.

This chart is much better than the former, for the mariner's uſe, becauſe the graduations may be much larger; and to make it more accurately, we ſhall uſe the table of meridional parts.

Example. Let it be required to make a mercator for a particular voyage, viz. from the Lizard in lat. 49 .55 North, to Antigua in lat. 17 .00 N. and long. 59 .30 W. (or for any of the lee-ward Caribee iſlands) × of longitude 54 .07 W. or 3240 miles, the meridianal difference of latitude between theſe two places being found by the table, to be 2471 miles.

Take a ſheet of of ſtrong paper as large as you intend your chart ſhall be, then chooſe ſome ſcale of equal parts of which 3240 may be the breadth, and 2471 the length or depth, with a convenient allowance for ruling, or what you think fit to draw for ornament about the out ſide of it; then towards the north eaſt (or upper right hand) corner, becauſe your courſe is ſouth weſterly.

Aſſume a point L for the Lizard, and draw a line right down the chart for the meridian of the Lizard, upon which ſet the meridional difference of latitude 2471 from the Lizard point, down the meridian to a point north, on which erect a perpendicular to the weſtward, and ſet off the difference of longitude 3249 from N to M, and this line (if you make the chart to the equinoctial) you may divide into every degree, or every two degrees or equal parts; finiſh your oblong with the other two ſides, or limits of your chart; draw a line down the middle of your chart, for the meridian, to be graduated, which you muſt thus divide; the meridianal parts, or meridianal difference of latitude, between the Lizard's lat. 49 .55, and next leſſer deg. viz. 49 .00 is 85 equal parts, ſet off on the ſame meridian from the parallel of the Lizard, or top of the chart downwards for 49 degrees of latitude.

Again,

Again, find the meridian difference of latitude between 49 .55 and 48 degrees of latitude; and ſo proceed with the reſt, which you may number with figures on the graduated meridian, and through every five or ten degrees, draw lines parallel to the top or bottom of your chart, for the parallels of latitude, and for the other meridians, draw parallels to the ſides of the chart, or to the graduated meridian; through every five or ten degrees of long. on the bottom or equinoctial line, and you may deſcribe the rhumbs or ſmall compaſs cards at any place or corners of the chart.

And then laſtly, for laying down any headlands, you may by the directions given in making the general chart; lay them down in their proper places; theſe charts are much more convenient for the Navigator's uſe, than even the globe itſelf, on which the rhumbs are ſpirals or crooked; and the diſtances of places the arch of great circle.

The Uſe of Mercator's Chart.

I. To find the latitude of any place in this Chart.

II. To find the courſe or bearing of any two places in this chart.

Theſe two problems are performed the ſame way on this chart, as before ſhewn in Problem firſt and third of the plain chart's uſe, and needs no example.

III. To find the longitude of any place in the chart.

The Rule. Take the neareſt diſtance from the propoſed place to any meridian, move the compaſſes (being kept at that diſtance) with one foot on the meridian, till both feet come on the equinoctial; and the foot which ſtood on the propoſed place ſheweth its longitude required. So the Lizard by this rule, will be found in Longitude of 5 14 Weſt, if the longitude is accounted from the meridan of London. But in 00 .00 if accounted from the meridian of the Lizard.

IV. To find the diſtance of any two places in this chart.

This admits of four caſes, viz. firſt when the two places are under one meridian, that is, bear north and ſouth of each other.

The Rule. Find the latitudes of the two places by problem firſt of this chart, and then the difference of latitude between them will be diſtance required; ſo that the diſtance between cape St. Vincent in Spain, in latitude 37 .15 north, and cape Cantin in Barbary, in latitude 32 42 N. is 4 .33 or 273 miles.

Caſe

Caſe 2d. When two Places are upon the Equinoctial or Equater, (bearing due Eaſt or Weſt,) to find their Diſtance.

The Rule. Find the difference of longitude between them, (as is ſhewn a little farther on) and it is the diſtance required; this is ſo eaſy that it needs no example.

Caſe 3d When the two Places bears due Eaſt and Weſt in one Latitude, or Parallel, to find their Diſtance.

The Rule. Take the diſtance between the two places, in the compaſſes, and lay the diſtance on the graduated meridian, ſo that one foot may be as many degrees above the latitude of the given place as the other below it; there ſtay the compaſſes, and count the degrees intercepted between the feet of the compaſſes, and it is the diſtance required.

Example. Required the diſtance between cape Roxant, going into Liſbon, and the iſle of Pico, one of the weſtern iſles, being both in latitude 38 deg. 00 min.

Take the diſtance between the ſaid places in your compaſſes, and place them on the meridian, ſo that one foot is ſo many degrees above given latitude 38 .30, as the other is below, the degrees intercepted between them, is found to be 13 deg. or 260 leagues diſtant.

Caſe 4th. When the Places differ both in Latitude and Longitude, being given to find the Diſtance.

Take their difference of latitude from the equinoxial, then lay a ruler on both the given places, apply that diſtance ſo to the rulers edge, that when one foot is placed cloſe to the ruler, and the other turned about, it may juſt touch ſome eaſt and weſt line, croſſed by the ſaid ruler's edge, their ſtay the compaſſes; then the diſtance by the ruler's edge from the place where the compaſſes reſted, to the place where it croſſed the aforeſaid eaſt and weſt line, meaſured on the graduated meridian, gives the diſtance required.

Example. Required the diſtance between the Lizard in latitude 49 .55 north, and Antigua in latitude 17 .15 north.

Latitude the { Lizard 49 .55 North
Antigua 17 15 North

difference of latitude 32 .40

Take 32 .40 in your compaſſes from the equinoctial, and the ruler laid over the Lizard and Antigua, and that extent applied as before directed, meaſured on the equinoxial, gives 56 .04 or 1144 leagues, the diſtance from the Lizard to Antigua, as was required.

PARALLEL

PARALLEL SAILING.

PARALLEL Sailing, is a branch of mercator ſailing, it is of uſe in ſailing eaſt or weſt, or in the ſame parallel of latitude, it is manifeſt from the ſcheme in plate ſecond, that the meridions incline from the equinoctial, nearer and nearer, till they meet or interſect in the poles of the world, north or ſouth; and conſequently the degrees of longitude grow leſs and leſs, the nearer you aproach the poles; and ſince the circumferences of all circles, are in proportion as their radius directly, and that like parts, have the ſame proportions with their wholes, it follows, that the breadth of a degree of longitude in any parallel of latitude, : is to the breadth of a degree of the equator : : As the ſine compliment of that latitude : is to the Radius. And conſequently as the miles in one, is the miles in the other.

Caſe 1th. Two Ships or Places in one Parallel of Latitude, their Latitude and Diſtance being given, to find thir ✕ of Longitude.

Suppoſe a ſhip ſails due eaſt 199 miles, in the parallel of 48 .58 N. I deſire to know my difference of longitude?

The Conſtruction. Pl. II. Fig. 76.

With the ſine of 90 or chord of 60 deg. deſcribe the arch E Q, then with the S. C. latitude 41 .02 on the ſame center P, draw the line P Æ, for the ſhip's meridian at firſt, and P Q her meridian after her ſailing 199 miles eaſt; laſtly draw P L and E Q, which meaſured on the ſame ſcale of equal parts you took the diſt. P L from, will ſhew the ✕ of longitude 306 miles.

Note, you may with half the diſtance ſailed, viz. 99 .5 ſet both ways, from *p* to *a* and *b*, and draw the parallels *a p* and *b* L, ſo will *a p* repreſent the ſhip at firſt, and L at laſt.

Trigonometrically.

As S. C. Latitude	41 .02	
Is to the diſtance	199	
So is Radius	90 .00	
To the ✕ of Longitude	30 .12	
	306.2	

Arithmetically.

65 65 = N. S. 41 .02 then ſay

: .6565 : 1 : : 199 : ——

.6565) 99.000 (303.2 the ✕ of Longitude required.

Caſe 2d. The Latitude and ✕ of Longitude being given, to find the Parallel of Latitude.

Let it be required to find the diſtance between the Lizard in England,

land, and Pengiven iſland, on the coaſt of Newfoundland; Lizard being in longitude 5 .24 E. and Pengiven iſland in longitude 53 .10 W. they being both in the latitude 50 00 N.

The Conſtruction. Pl. II. *Fig.* 77

Deſcribe the arch Æ Q, with the fine of 90 or chord of 60 deg. and ſet off 1433, half the difference of longitude from P to *a* and *b* both ways, and let fall the perpendiculars *a* E and L Q. and draw the lines P Æ and P Q, ; then with the S. C. Lat. 40 taken from the fines, deſcribe the arch N L, erecting Æ P and Q P in N and L; draw the lines N L, and Æ Q; ſo is N L the diſtance, and Æ Q the difference of longitude.

Longitude	Pengiven Iſland	53 .10	From 90 .00	
	Lizard	5 .24	Sub. 50 .00	
		47 .46	C. Latitude 40 .00	
		60		
Difference of Longitude		2866		

Trigonometrically.

As Radius	90 .00	10.
Is to × of lon.	2866	3.457276
So is S. C. lat.	40 .00	9.808067
To the diſt.	1842	3.265343

Arithmetically.

Thus, N. S. 40 .00 = .6428.
Then, 1 : 2866 : : .6428
Then 6428 × 2866 = 842.2 miles, the diſtance required.

Caſe 3d. The Diſtance and × of Longitude being given, to find the Parallel of Latitude.

Suppoſe there being two iſlands bearing due eaſt and Weſt of each other, their diſtance aſunder being 210 leagues, and the × of longitude between them is 341 leagues; I demand the parallel of latitude they are in.

Geometrically Conſtructed. Pl. II. *Fig.* 78

With the fine of 90 deg. deſcribe the arch Æ Q, then ſet half the × longitude = 170, from P to *b* and *a* both ways, and let fall the perpendiculars *d* Æ and *b* Q; and draw the lines Æ P and Q P, then ſet half the diſtance 105 from P to *c* and *a* as before, and let fall the perpendiculars *c* N and *a* L, and draw N L, and Æ Q, and the thing is done.

Trig-

Trigonometrically.		*Arithmetically.*
		341 : 1 : : 210 :
As the × of Longitude	341	341)210.0000(.6158 the
Is to Radius	90 00	N. S. of 38.01 for the C. Lat.
So is the diſtance	210	Whence the latitude the iſlands
To S. C. Latitude	38 .01	are in, is 51 .59 N.

Caſe 4th. Suppoſe two Ships in one Parallel of Latitude, their Diſtance in that Parallel given, and ſailing both directly North or South, to find their Diſtance in another Parallel.

Example. Suppoſe two ſhips under the equinoctial 342 miles diſtant, and they ſail both due north, till they are in latitude 49 .37 N. I demand their diſtance aſſunder then.

The Conſtruction. Pl. II. *Fig.* 79

With th fine of 90 or chord of 60, deſcribe the arch A Q, then ſet off half the difference of longitude 171 both ways, from P to *d* and *b*, let fall the perpendiculars *d* Æ and *b* Q, and draw P Æ and P Q, then with the S. Co. parallel lat. 40 .23; deſcribe the arch N L, cutting the lines PA and P Q, in N and L, then draw NL and Æ Q. and N L is their diſtance aſſunder, in the parallel of 49 .37 = 177 the anſwer required.

Trigonometrically.		*Arithmetically.*
As Radius	90 .00	The N. S. of 40 .23 is .648
Is to their diſtance at firſt	342	Then 648 × 342 = 216.6 miles,
So is S. C. Latitude	40 .23	their diſtance in the latitude come
To their diſtance under them	221.6	to, as required.

Caſe 5th. Suppoſe two Ships in one Parallel of Latitude, their Diſtance in that Parallel given, and ſailing both directly North or South, and then their diſtance in the parallel come to given, to find the parallel of Latitude come to.

Suppoſe two ſhips under the parallel of 10 .17 N. their diſtance aſſunder being 328, and they ſail both due north, till they are but 86 miles aſſunder. I demand what latitude they are in then.

The Geometrical Conſtruction. Pl. II. *Fig.* 80

With the fine 79 .43, deſcribe the arch O Q; then ſet 164, half the given diſtance from P to *b* and *d*, both ways, and let fall the perpendiculars *d* Q and *b* Q, and draw the lines O P, and Q P; then ſet off

43, half their diſtance at laſt, both ways, from P to *a c*, and let fall the perpendiculars *c* N, and A L, then P N, and P L will be the S. C. latitude required.

Trigonometrically.

As their diſtance at firſt	328
Is to S. Co. parallel	79 .43
So is their diſtance at laſt.	86
To the S C. lat come to	14 .57

Whence they are come to latitude 75 .03 N.

From 90 .86
Subtract 10 .17

79 .43

Arithmetically.

N. S. 79 .43 = .9839
Then 328 : .9839 : : 86

$$\therefore \frac{.9839 \times 86}{328} = .2579$$

the N. S. of 14 .57. Co. lat.

Queſtions to Exereiſe the foregoing Caſes.

Suppoſe two iſlands or headlands, in the latitude 71 .51 N. diſtant aſſunder 255 leagues, the eaſtermoſt is in longitude 21 .55 Weſt; I deſire to know what longitude the weſtermoſt ſhip is in?

This Queſtion is projected as the 1ſt. Caſe in parallel ſailing.

Trigonometrically.

As S. C. latitude	18 .09
Is to the diſtance	255
So is Radius	90 .00
To the × of long.	819

From 90 .00
Sub. 71 .51

18 .09

Arithmetically.

N. S. 18 .09 = .3115. Then

$$.3115 : 255 : : 1 : \frac{255 \times 1}{.3115}$$

= 819 leagues, the × of longitude the ſame as above.

Then 819 ÷ 20 = 40 .57 W
Long. Eaſtermoſt Iſland 21 .55 W

Longitude weſtermoſt Iſland as required } 62 .52 W

Queſtion 2d Suppoſe two ſhips in latitude 40 .00 North, diſtant aſſunder 300 leagues, they both ſail due ſouth the ſame diſtance, till they come under the equinoctial; I demand their diſtance aſſunder there; and if the eaſtermoſt ſhip be in the longitude 20 .15 W. the ſun being on her meridian; I deſire to know the longitude of the weſtermoſt ſhip, and likewiſe the hour of the day?

The Geometrical conſtruction of this queſtion, is the ſame as that of the third Caſe.

Trigo-

Trigonometrically.

As S. C. latitude	50 .00	From	90 .00
Is to the distance	300	Sub.	40 .00
So is Radius	90 .00	Remains	50 .00
To the × of longitude	392		

The × of longitude or distance between the ships on the equator, is 392 leagues, and $\frac{392^2}{20} = 19.36$.

The longitude Eastermost ship	20 .15 W.
The difference of longitude	19 .36 W.
Longitude Westeremost ship	39 .51 W.

Found as in the last Example.

Now Since longitude and Time, are reckoned on the equinoctial, and that every 15 degrees of the suns diurnal motion in the heavens, is equal to one hour of time on the earth, therefore divide the difference between the ships by 15 as below, and the quotient gives the difference in time between them.

Divide by the ratio of 15 viz. 5 and 3, and the quotient is 1 hour, 18 min. 24 seconds of time.

Which subtracted from 12 hours, and the remainder will be 10 h. 41 min. 6 sec. the hour of the day at the Westermost ship, when it is noon at the eastermost ship.

Thus 5)19 .36

3) 3 .55 .12

Hour	1 .18 .24
Sub. from	12 .00 .00
Remains	10 .41 .36

MIDDLE LATITUDE SAILING.

OR, a method of sailing nearly agreeing with mercator, and performed without a table of meridional parts, and may be wrought by logarithms and the Gunter's scale; which is thus, having first taken an arithmetical mean between the two latitudes, that is by adding the latitude you sail from, to the latitude you are bound to; half that sum shall be the mean, or middle latitude; then we have this theorem, or proportion; As the sine complement middle latitude: is to the difference of meridians :: so is radius: to the difference of longitude. Now if you change the sine compliment middle latitude, into sine complement parallel latitude, and of departure or difference of meridians

meridians into middle due East or due West, in a parallel, the proportion is the same with the first case in parallel sailing before going.

Case 1st. *Both Latitudes and Longitudes of two places being given to find the Course, distance, and Difference of Meridians.*

Suppose a ship sails from cape Clear in latitude 51 .10 N. and longitude 10 .30 W. to cape Henry in latitude 37 .00 N. and longitude 74 .30 W. her course, distance, and × of meridians is required?

The Geometrical Construction. *Pl* II. *Fig.* 69.

Draw D B the meridian or north and south line, then as in the first case in plain sailing with the complement middle lat. 45 .55 (as course) and × of longitude 1280 leagues; project the triangle A B C.

2dly. B A being continued to D, make A D = the × of latitude 203 leagus, and draw D C the rhumb line or distance, so shall D represent cape Clear, and C cape Henry, the ∠ D A the course D C the distance from cape Clear, and A C the westing from cape Clear, all which may be measured by the chords and equal parts, as is shewn in the foregoing problems of mercator sailing.

Trigonometrically.

Latitudes	51 .10 N.	55 .10	Longitudes	74 .30 W.	
	37 00 N.	37 .00		10 .30 W.	
	88 .10	14 .10		64 .00	
		60		60	
middle lat.	44 .05				
		× of lat. 3)550(183 leag.		3)3840	
Co. m. lat.	45 .55				

difference of long. in leagues 1280

As radius	90 .00	10.
Is to the × lon.	1280	3.10721
So is S. C. m. lat.	45 .55	9.85632
To the × merid.	919.5	2.96353

As × of latitude		283
Is to Tangent Radius		45 .00
So is difference of merid.		919.5
To the Tangent course		72 .53

As S. C. 72 .53 : × merid. 9195 :: R. 90 .00 :: dist. 962.1 leag.

Arithmetically.

N. S. M. lat. 45 .55 = .7153
Then 1 : 1280 :: .7183 :
1280 × .7182 = 919.4 the difference of meridians.

To find the distance.

N. S. of 72 .53 is .9557
Then .9557 : 919.4 :: 1
therefore .9557)919.4000(962.1
hence the distance is 962.1 leag.

To

To find the courſe,

283 : 1 : : 919.4. then 283)919.4000(.3249 N. S. = 72 .53 the courſe required.

Here we find that middle latitude, ſailing, as always thus been practiſed, will not agree with mercator which muſt be allowed the true way, as in this example, between cape Clear, and cape Henry, for mercator makes the courſe S. 72 .46, and middle latitude S. 72 .53; the diſtance by mercator is 955.2 leagues, and by middle latitude is 962.1, differing 6.9 leagues. Mercator makes the departure or × of meridians 912.3 leagues, and middle latitude, 919.5 leagues; which differs 7.2 leagues.

Example 2d. Suppoſe a ſhip ſails from the Lizard in latitude 49.55 N. and longitude 5 23 W. being bound for Antigua in latitude 17.15 N. and longitude 61 .44 W. I deſire to know her courſe, diſtance, and difference of meridians.

Geometrically .Pl, Fig, 70

Draw the meridian B D for the meridian; make the ∠ D B C = 56 .25 the compliment latitude, and make B C = 3381 miles, from your ſcale of equal parts, projecting the ∠ B A C, then ſet the × of latitude 1960 from A to D, and draw the line A D; laſtly draw the line D C, which will be the diſtance required.

Trigonometrically.

Lati.	Lizard	49 .55 N.	49 55 N.	Lon.	Antigua	61 .44 W.
	Antigua	17 .15 N.	17 15 N.		Lizard	5 .23 W.
Sum		67 .10	32 .40			56 .21
			60			60
M. latitude		33 .35	1960		× of long.	3381
Co. M. lat.		56 .25				

As radius	90 .00	10.
Is to the × long.	3381	3.529045
So is ſi. co. m. la.	56.25	9.920658
To the × merid.	2817	3.449733

As S. cour.	55 .10	9.914246
Is to × of mer.	2817	3.449733
So is Radius	90. 00	10.
To the diſtance	3431	3.538487

As × of lat.	1960	3.292256
Is to T. Radius	45 .00	10.
So is × merid.	2817	3 449733
To the T. cou.	55 .10	10.157477

Arithmetically.

To find the × of meridians.

N. S. 56 .25 = .8329

1 : 3381 : : .8329. Then 3381 × .8329 = 2816.

To

To find the course.

1960 : 1 : : 2817
1960)2817.0000(1437 the N. T. of 55 .10.

To find the distance.

N. S. 55 . 10 is 8208 Then
8208 · 2817 : : 1
8208)2817.000(3432 hence the distance is 3232 leagues.

Example 2d. Suppose a Ship sails from the Lizard in Latitude 49 .55 *N. and longitude* 5 .14 W. *to Cape Horn in Latitude* 57 .58 S. *and Longitude* 79 .55 W. *required her Course, Distance, and* × *Meridians?*

By Mercator's Sailing.

The course is found to be S. 30 .01 westerly; Distance 746 miles, and × of meridians 3740 miles; now we shall have the difference between mercator and middle latitude in a long run.

Lizard	49 .55 N.	49 .55 N.		cape Henry 79 .53	W
cape Horn	57 .58 S.	57 .58 S.		Lizard 5 .14	W
	3)107 .53	107 .53		74 .41	
	35 .58	60		60	
	× latti.	6473		× of long.	4451
Mid lat.	54 .02				

Then,

As Radius 90 .00 10.
Is to the × lon. 4481 3.651375
So is S. c. m. lat. 54 .02 9.908141

To the × of mer. 3627 3.559546

To find the course.

As the × of lat. 6473 3.811136
Is to ta. Radius 45 .00 10.
So is × of merid. 3627 3.559516

To the tan. cou. 29 .16 9.748410

To find the distance

As S. C. 26 .16
Is to × M. 3627
So is Radius 90. 00
To the dist. 7419 miles, the distance required,

Arithmetically.

To find the difference of Meridians.

N. S. 54 ,02 = .8094

Then 1 : 4481 : : .8094

4481
8094

17924
40329
358480

3626.9214

Hence the difference of Meridians is 3627 miles

To

To find the Course.

6473 : 1 : : 3627
6473)3627.0000(.5603
32365 = N. T. of
29 .15 the
course.
38050
38838
21200
19419
1781

To find the Distance.
N. S. 29 .15 = 4886 Then
.4886)3627.0000(7423
34202
Here the dis-
20680 tance is found
19554 to be 7423
miles.
11360
9772
15880
14608
1104

Example 4th. Suppose a ship sails from cape Cod in New England, in Latitude 42 .10 N. and Longitude 67 45 west to cape Bona Esperanse. or the cape of Good Hope in Latitude 34 25 south, and Longitude 17 25 east required her Course, Distance, and difference of meridians.

In the solution of this question, I shall here shew how much mercator and middle latitude sailing differs from each other in a large run; as the operations both ways are here performed both Trigonometrically and Arithmetically.

By Mercator thus,

cape Code	42 .10 N.	2795	cape Cod	67 .45 W
cape Good Hope	34 .25 S.	2202	cape Good Hope	17 .25 E
	76 .35	m. × lat. 4997		85 .10
	60			60
× of latitude	4595		× of longitude	5110

To find the × of meridians
As the meridian × of lat. : : × of long. : : So is prop. × of lat. to the × of meridians.
4997 : : 5110 : : 4595
4595
25550
45990
25550
20440
4997)23480450(4699 the × of meridians.

Answer. Course S. 45 .39 easterly or S. E.
Distance 6571 miles, diff. of meridians 4699 miles.

By middle Latitude.
When one latitude is N. and the other S. take one third of their sum for the true middle latitude.

cape Cod Latitude	42 .10 N
cape of Good Hope	34 25 S.
There Sum	76 .35
One third is mid. lat.	25 .32
Comp. middle latitude	64 .28

Trigonometrically.

By Mercator

To find the Course.

As prop. × lat. 4595 3.662285
Is to T. Radius 45.00 10.
So is × of merid. 4699 3.672005

To the T. course 45.39 10.009720

To find the Distance.

As S. course 45.39 9.854356
Is to × of merid. 4699 3.672005
So is Radius 90.00 10.

To the Distance 6571 3.817649

To find the differ. of meridians.

As Radius 90.00 10.
Is to diff. of lon. 5110 3.708421
So is S. C M. L. 64.28 9.955268

To the diff. mer. 4611 3.663689
Difference of meridians 4611 m.

By Middle Latitude

To find the course

As diff. of latitude 45 95 3.66228
Is to tan. radius 45.00 10.
So is × of merid. 46 11 3.66378

To the tan. course 45 06 10.00150

To find the distance.

As sine course 45 06 9.850242
Is to the × of mer. 4611 3.663780
So is radius 90 00 10.

To the distance 65 10 3.813538

Here we find the course by middle latitude differs from mercator, (or the true way of sailing by od. 33m. distance also differs 61m. and × of meridians 88 miles only in the space or distance of 65 10 miles run.

But when I have gone through the 8 cases of middle latitude I shall give an essay on middle latitude which will make it agree with mercator very near.

To Work this Example Arithmetically, Pl, II, Fig, 85,

To find × of meridians

N. S, 64 28 is 90 23 then,

1 : 5110 : : ,9023
,9023

15330
10220
459900

4599 : 0.753,

Hence the × of meridians is 4011 miles

To find the Course,

As × of latitude . T. Radius : : × of Meridian : T, Course

4595 : 1 : : 4611 :

4595)4611.0000(1,0034 = N. T. of 45 .06
4595

16000
13785

22150
18380

To

To find the Distance.

As S. C. : × of meridians : : So is Radius : to the Distance.
N. S. 45 .05 is ,7084 ——— .7084 : 1 : : 4611
,7014)4611.0000(6511 Here the difference of meridians is found = 6511 miles.

Case 2d. Both Latitudes and Course being given to find the Distance, difference of Meridian, and difference of Longitude.

Suppose a ship sails N. W. half W. from a certain Road in latitude 50 .5 N. and longitude 21 37 E. to the latitude 57 .33 N. I demand her distance, difference of meridians, diff. of longitude and longitude come to?

Latitudes	57 .33 N.	57 .33
	50 .51 N.	50 .51
Sum	108 .24	6 .42
		60
Mid. lat.	54 .12	
		3)402
Co. M. lat.	35 .48	
		134

The Geometrical Construction.

By case 2d. of Plain Sailing, Construct the Triangle A B C, with course N. 51 38 W. and dif. of latitude 134 leagues given.

Make the ∠ B C D equal the middle latitude 54 .12 and draw the line C D, till it meet with the dif. of latitude A B produced in D. so shall D C, be the dif. of longitude, and the ∠ B, C D, the middle latitude and the ∠ B D C = Co. middle latitude.

Trigonometrically.

As S. C. cou.	39 .32	9.802282	For the difference Meridians.		
Is to × of Lat.	134	2.127100	As Radius	90 .00	10.
So is Radius	90 .00	10.	Is to the dist.	211.3	2.32482
			So is S. Course	50 .38	9.88824
To the Distance	211.3	2.324523	To × of mer.	163,4	2.21306

To find the difference of Longitude.

As S. Com. mid. latitude	35 .48	9.767124
Is to × of meridian	1634	2.213060
So is Radius	90 .00	10.
To the difference of Long.	279.2	2.445936

To

279
3
60)837

diff. of Lon. 13.57 W.
Lon. depar. 21.37 E.

Lon. come to 7 .40 E.

To work this Example Arithmetically.

To find the diſtance.

N. S. 39 .22 is, 6343
Then, 6343 : 1 : : 134.
.6343)134.0000(211.2 = hence the diſtance 211.2 miles.

To find he × of meridians.

N. S. 50 .37 is = ,7721 then
1 : 211.2 : : ,7721 : 163.35 &c.
= the × of meridians 193.35 miles.

To find the difference of Long.

N. S. 35. 48 the middle latitude is .585

Then 585 : 163.4 : : 1
That is .585)163.4000(279.3

Here the × of Longitude is 279.3 miles, and the diſtance is 211.2 miles, × of meridians, 163.4 miles, Longitude come to 7 .40 E. as was required.

Caſe 3d. Both Latitudes and Diſtance being given to find the Courſe difference of Meridians and difference of Longitude.

Example. Suppoſe a ſhip ſails in the S. W. quarter, from a certain port in latitude 57 .59 N. and longitude 8 .17 E. till by obſervation ſhe is in latitude 49 .53 N and makes her diſtance 266 leagues, required to find her courſe, difference of meridians, diff. of longitude and longitude come to?

Latitudes	57 .59 N.	57 .59
	49 53 N	49 53
Sum	107 52	8, 06
		60
Middle lat.	53 56	
		× of lat, 486 m.
Co. mid, lat.	36 04	
		or 162

Geometrical Conſtruction. Pl, II, Fi. 86,

With the diſtance 266 leagues, and difference of latitude 162 leagues, make the triangle A B C, by caſe 4th of Plain Sailing, continuing A B to D, make (as in the laſt caſe) the ∠ D C B, = middle latitudes 53 .56 and draw C D for the × longitude.

Tri

Trigonometrically,

As the diſtance	266	2.424882
Is to Radius	90 .00	10.
So is ✕ of lat.	162	2.209515
To S. Co. cou.	37.31	9 784633
As Radius	90 .00	10,
Is to the diſt.	266	2.424882
So is S. courſe	52 29	9.899370
To diff. of mer.	211	2.324252
As S. C. M. lat	36 .94	9.769913
Is to diff. of mer	211	2.324252
So is Radius	90 .00	10.
To dif. of long.	358.4	2.554339

20)358

Dif. of Long. 17 .54 E.
Long. depar. 8 .17 E.

Lon. come to 26 ,11 E.

Anſwer.

Courſe South 52 .29 Eaſterly, or near S. E. three quarters E.

Difference of meridians 211 lgs.
Difference of Long. 358 lgs.
Longitude come to 26.11 E
As was required.

Arithmetically ſolved thus,

For the Courſe.

Diſt. 266: R. 1 :: 162 dif. m. S. C.
Then 265). 162.0000(609
The N. S. of 38 01 = S. C. Cou
S. Cou. = 51.59 its N. S = .7879

For the diff e rence of Meridians.

R. 1 : : 266 diſt. :: ,7879 S. C. dif. m.

Then 266 ✕ .7879 = 210 the difference of meridians.

For the difference of Longitude.

Natural Sine 36 .04, — the Com. M. Latitude. 589
Then S, C, M, Lat, : dif, of M, : : Radius : diff, of Longitude,
,589 : 210 : : 1 : 355 the difference of longitude,

Caſe 4th. Both Latitudes and difference of Meridians being given to find the Courſe, Diſtance, difference of Longitude, and Longitude come to.

Example. Suppoſe a ſhip ſails in the S. W. quarter, from a certain Road in latitude 57 , 9 N. and Longitude 22 .17 W. until by obſervation ſhe is in latitude 49 ,05 N. and makes her difference of meridian 188 leagues; I demand her courſe, diſtance, difference of longitude, and longitude come to?

Latitudes

Latitudes	55 .19 N.	57 .19
	49 .05 N	49 00
Sum	104 24	8 14
		60
Mid. lat.	53 12	
		Dif. of lat. 594
C. M. lat.	36 48	
		164

Trigonometrically.

As × of Lat.	165	As S. Course	48 .44
Is to Tan. Radius	45 .00	Is to diff. of mer.	188
So is diff. of merid.	188	So is Radius	90 00
To the Tan. Cou.	48 .44	To the distance	250

As S. C. mid. lat.	36 .48
Is to diff. of mer.	188
So is Radius	90 .00
To the dif. of Lon.	313.7

The Geometrical Projection. Pl II, *Fi*, 57

With the difference of latitude 165 leagues, and the distance 188, project the triangle A B C, by the 6th Case of Plain sailing.

Make the ∠ B C D = middle latitude = 53 .12 and draw C D for the difference of longitude as before.

Arithmetically.

To find the Course.

Diff. lat. : T. R. : : dif. m. : T. C.

165 : 1 : : 188 : 1.139
165)188.0000(1.40 =
N. Tangent 48 .43 the course

To find the distance

S. C. : diff. M. : : Radius : Dist.

N. S. 48 .43 = .7515
.7515 : 188 : : 1 : 250.1
.7515)188.0000(250.1
= the distance required.

To find the difference of Long.

N. S. 36 48 = .599
As S. C. mid. lat. : dif. mer. : : R. : dif. lat.
.599)188.0000(213 8 the difference of longitude required.

$\frac{213 \times 3}{60} = 10.41$ W.

Long. departed 22 .17 W.

Long. come to 32 .58 W.
Course S. 45 .43 Westerly, or S. W. quarter W.
Distance 250 leagues.

Case

Case 5th One Latitude, Course, and Distance being given, to find the difference of Latitude, difference of Meridians, and dif. of Longitude,

Example. Suppose a ship sails S. E. by S. three quarters E. from a certain port in Latitude 51 .37 N. and longitude 21 .51 E, making her distance 355 miles; I demand her difference of latitude, difference of meridians, diff. of longitude, and latitude and longitude come to?

Geometrical Construction P. II, Fig. 58,

Project the triangle A B C, with given course S. E. by S. three quarters E. = 42 .11 and the given distance 355 miles, by the method in First Case of Plain Sailing, and after the difference of latitude is found, make the ∠ B C D, = S. C. M. Lat. = 49 .25 and draw D C, which will be the difference of longitude.

Trigonometrically.

As Radius	90 .00	10.
Is to the dist.	355	2.550225
So is S. Course	42 .11	9,827049
To dif. of mer.	235.4	2.377277

As Radius	90 .00	10.
Is to the dist.	355	2.550225
So is S. C. C.	47 .49	9.869816
To the × of lat.	263 1	2.420046

S. C. M. lat.	40 .35	9.81328
× of Merid.	238.4	2.377277
Radius	90 .00	10.
Dif. of Long.	366	2.56399

60)26 (=4 .23 S. Lat. dp. 51 .37 N. — L. come to 47 14 N
Sum S. 98.51
M. lat. 49 35
C. o. M. Lat. 40.35

Dif. of Lon. $\frac{366}{60}$ = 6 .06 E.
Longitude departed 21 .51 E.
Longitude come to 27 .57 E.

Difference of Lat. 263.1 miles
Dif. of Meridian 238.4
Dif. of Longitude 366.1
Latitude come to 47 .14 N.
Longitude come to 27 .57 E.
The Answer.

Arithmetically.

To find the Departure.

N. S. 42 .11 is = 6715
R. : Dist. : : S. C. : depar.
1 : 355 : : .741 : : $\frac{.6715 \times 355}{1}$
= 238 .38 = the departure or difference of meridians.

To find the dif. of Latitude.

N. S. 47 .49 is = .741 Then
R. : Dist. : : S C C : dif. L.
1 : 355 : : .741 : $\frac{741 \times 355}{1}$ =
263 ,055 the dif. of Latitude.

To

To find the diff. of Longitude.

N. S. 40 .35 is .6505 — Then S C mid. Lat, : dif, M, : : R, : dif. long.

.6505 . 218,3 : : 1 : $\frac{218,3 \times 1}{6508}$ = 366,3 the dif, of Long, required.

Case 6th One Latitude Course and difference of Meridians being given, to find the distance, difference of Latitude, difference of Longitude and latitude come to,

Example. Suppose a ship sails N. W. by N. half W. from a certain road in latitude 50 .19 N, and longitude 27 .57 W. until her difference of meridians be 177 miles; It is required to find the distance, difference of latitude, difference of longitude, and latitude and longitude come to?

To find the Distance, and difference of Latitude Trigonometrically.

As S. Course	39 ,22	9,802281
Is to dif, of mer.	177	2,247973
So is Radius	90 ,00	10,
To the distance	279	2,445692
As Radius	90, 00	10,
Is to the distance	279	2,445692
So is S, C, C,	50 ,38	9,888257
To dif, of lat,	215,8	2,333929

To find the diff, of Longitude.

As S, C, M, lat.	37 ,53	9,787883
Is to dif, of mer,	177	2,247573
So is Radius	90 ,00	10,
To dif, of long,	288,4	2,459690

60)216(= 3,26

Lat, departed 50 .19

Latitude come to 53 ,55

Latitude departed 50 ,19 N,

Latitude come to 53 55 N,

Sum 2(104 ,14

C, mid, latitude 52 ,07

C, mid latitude 37 .55

The Geometrical Construction, Pl, II, Fig, 89,

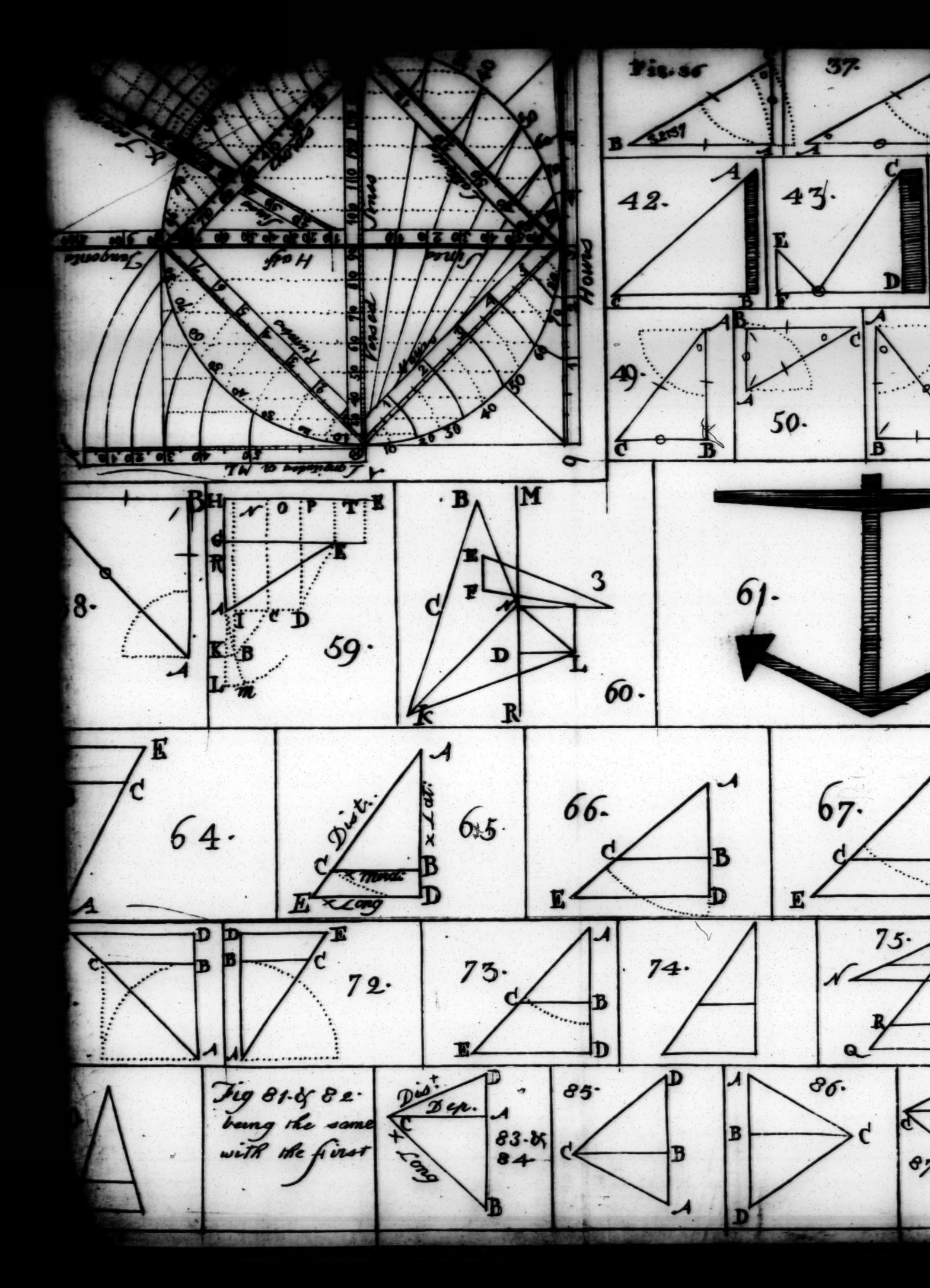
The same as the third Case in Plain sailing for making the triangle A B C, and make the angle B C D, with the middle latitude 52 ,07 and C D will be the difference of longitude, required.

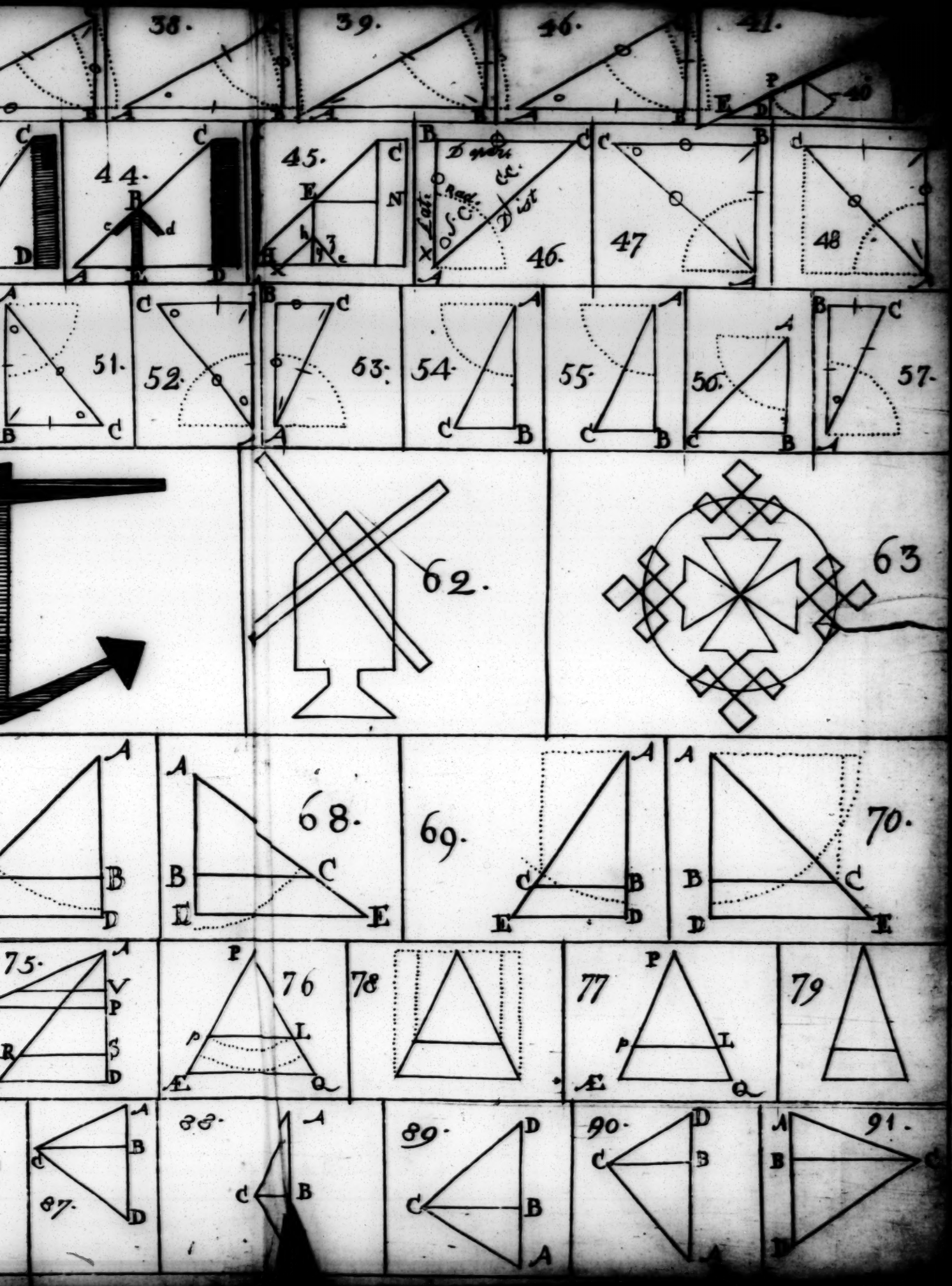
The same Proportions done Arithmetically.

For the Distance, —— N, S, 39 ,22 is ,6343

S, C, : dif, mer, : : R : dist, ——, 6343 : 177 : : 1 : $\frac{177 \times 1}{,6343}$ = 279 the distance.

To


Fig. 36
37.
42.
43.
49.
50.
61.
59.
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66.
67.
72.
73.
74.
75.
Fig 81. & 82.
being the same
with the first
83. & 84.
85.
86.


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89.
90.
91.



Arithmetically.

To find the difference of Long. — N. S. 27 51 = .6136
As S. C mid. lat, : dif, mer. : : R. : dif Longitude.

$$,6136 : 177 :: 1 : \frac{177 \times 1}{,6316} = 288.4 \text{ the dif, of Long.}$$

To find the dif. of Latitude.

N. S. 50 .38 is = .7731 Then
R. : Dist. : : S C C : dif. L,
1 : 279 : : ,7731 :
·7731 × 279 = 215 .6949 or 215.7 the dif, of latitude.

The Answer.

Distance	27	miles
Difference of Lat.	2 57	
Dif. of Longitude	288.4	
Latitude come to	59 59 N.	
Longitude come to	32 .45 W.	

Case 7th One Latitude Distance and difference of Meridians being given, to find the Course, difference of Latitude, and difference of Longitude.

Example. Suppose a ship sails in the S W. quarter from a certain road in latitude 47 .33 N, and longitude 55 .17 E. making her distance 449 miles and her difference of meridians 347 miles; I demand her course, difference of latitude & of longitude, and latitude and longitude come to?

Geometrical Construction Pl, II, Fig, 90,

This is Constructed the same as the fifth Case in Plain Sailing. viz. by measuring the triangle A B C, with the distance A C. = 449, and base B C = a A = 347 miles, then make the angle B C D, with the middle latitude and the side C D is the difference of longitude.

Trigonometrically.

As the distance	449	2,652246	As Radius	90, 00	10,
Is to Radius	90 ,00	10,	Is to the distance	449	2,652246
So is dif, of mer.	347	2,540329	So is S, C, C,	39 ,24	9,802089
To S. Course	50 ,36	9,888083	To dif, of lat,	285	2,454835

As S, C, M, lat. 44 ,50 9,848218
Is to dif, of mer, 147 2,540329
So is Radius 90 ,00 10,

To dif, of long, 492,2 2,992111

60)285(=	4,45 S,		60)492(=	8,12 W
Lat, departed	47,33 N,		Long, departed	58,17 E,
Latitude come to	42,48		Lon. come to	50.05
Sum lat.	90,21			
Middle latitude	45,10			
Com. Mid. Lat,	44,50			

The Proportions wrought Arithmetically.

To find the difference of Latitude by Square Root.

449 × 449 = 201601 sq, dist,
347 × 347 = 120409 sq, dif, mer.

Remains 80192 sq, dif, lat.

Whose square Root is 285 miles.

To find difference of Longitude.
N. S. C. M. L. 44.50 is = 7051
S. M. L. : dif, m, : : R. : dif, lon.

$.7051 : 347 :: 1 : \frac{347 \times 1}{.7051} =$

492.2 the diff. of Long. required.

To find the Course.

Dist, : R, : : dif. of mer, : S. C,

$449 : 1 :: 347 := \frac{347 \times 1}{449} =$

7728. The N. S. of 50,36 the S. C, Course 90 degrees — 50,36 = 39,24 the fi. comp,

Answer.

Coourse south 50,36 westerly
Diff. of Latitude 285 } miles
Diff. of Longitude 492 }
Latitude come to 42,45 N.
Longitude come to 50,05 E,

Case 8th. One Latitude, difference of Meridians and difference of Longitude being given, to find the Course, Distance, and difference of Latitude.

Sailing in the S. E. quarter from the Latitude 55,19 N. and longitude 46.46 E, to the longitude 51, 31 E, until our difference of meridians is 167 miles; I demand my course, distance, difference of latitude, and latitude come to?

Longitude	51,31 E.
Longitude	46,46 E.
	4,45
	60
	285

As the dif, of long,	255	2.454845
Is to Radius	90.00	10.
So is × of merid.	167	2.222716
To S. C. m. lat.	35.52	9.767871

To find the Course.

As the diff. of lat.	142	2.152288
Is to T. Radius	45.00	10,
So is dif, of merid.	167	2.222716
To T. course	49.38	10.070428
As S. Course	49.38	9.881907
Is to diff. of mer.	167	2.222716
So is Radius	90.00	10.
To the dist.	2192	2.340809

From

From	90 .00	Sum Lat.	108 .16
Sub. C. M. L.	35 .52	Lat. departed	55 .19
Remains	54 .08 M. lat.	Lat. come to	52 .57
	2		2 .22
			60
Sum Lat.	108 .16	Diff. of Lat.	142

Geometrical Conſtruction. Pl. II, *Fi.* 90,

With the difference of Longitude and difference of meridians, make the △ D B C by the 5th caſe of plain ſailing, and meaſure the angle B D C on the line of chords gives 35 .52 the middle latitude; from whence the latitude come to, and the difference of latitude is found, then with the difference of latitude 142 and difference of meridians 167, project the triangle A B C by the 6th caſe of plain ſailing, and angle B A C meaſured on the chords will be 49 .38, and diſtance A C will be 219.2 miles.

Arithmetically.

$255 : 1 :: 167 : \frac{167 \times 1}{289}$ =	$.142 : 1 :: 1\,167 : \frac{167 \times 1}{142}$ =
.5859 the N. S. of 35 .52 the Complement Middle Latitude.	N. T. 49 .38 the Courſe, or S. E. half E. neareſt.
From whence diff. of lat. 142	

And for the diſtance.

$\sqrt{167^2 + 142^2} = 219.2$ the diſtance in miles. QEI.

VARIOUS are the opinions of Writers upon Navigation concerning middle lat. ſailing, ſome making it agree with mercator ſailing, whilſt others give it very little preference to plain ſailing. And indeed, whether the earth and ſea, form a ſphere or oblate ſpheroid, it matters not, for it varies as well in the one as in the other, ſo as between ſome places to agree with mercator; and between other places with plain ſailing, whence it is evident that between ſundry places, it may be in any ratio between both; all which varieties are owing to this ſingle miſtake, that half the ſum of both latitudes is the true middle latitude for all places, which opinion muſt be very abſurd even when both latitudes having one name, but much more when they have different names, as is evident to any perſon who will but conſult either of the ſaid forms of the ſeas.

In order to rectify this abſurd opinion, by fixing a true middle latitude, without any ſenſible error between any two places, without having

ing recourse to tables, or burthening the memory, is the intent of this Essay.

It is known to every Philomath, that mercator sailing is grounded on an extended middle latitude, from which consideration only we get this general rule. As the merid. × of latitude : is to Radius : : so is the proper × of latitude : to the co sine of the true middle latitude in all places. Hence a table may be made for working middle latitude sailing as correct as by mercator, and for the same principles these were made for all latitudes; but then we shall have more trouble to find the middle lat. from thence than by working mercator sailing by meridional parts; to remedy which I calculate the middle latitude by this Rule. To every 5, 10, 15, 20, &c. 075 degrees of latitude from the equator, which will be found to serve very well, then take the difference or excess of latitudes to every 10, 15, 20, &c. to 75, and of these an arithmetical mean, by which is composed the following table, for its ease may be learned in less than half an hour, and comes nearer to mercator's tables for all latitudes, than any other of its extent, and runs vastly proportional thereto, with respect to the increase of latitude, but it must be observed through this Essay, that what is meant by excess of latitudes is their common difference, whether they be of the same or different names; as for instance if one latitude be 27 deg. and the other 45 deg. either north or south, or both, the excess is 18 deg. as well in one as the other. From this general rule are deduced the following cases.

Excess of Latitudes

D.		D. M.
10		0 30
15		1 00
20		2 00
25		3 00
30		4 00
35		5 30
40	Then Add	7 00
45		9 00
50		11 00
55		13 00
60		15 00
65		18 00
70		21 00
75		24 30

Case 1st. When both places are in North or both in south latitude, half the sum of both latitudes is the true middle latitude, except when the excess of lat. is 10deg. add 30m to the sum of both lat, and half that sum is the true middle latitude agreeing with mercator, which I shall illustrate with variety of examples, and compare the same with the common rule of working middle latitude and mercator sailing, whereby the practical navigator (for whose use this Essay is made public) may judge of the utility of the method.

Example 1st. Required the middle latitude between north Foreland, in latitude 51 ,28 N. and longitude 1 ,24 E. to North Bergen in latitude 60 ,16 N. and longitude 11 .04 E.

Bergen lat.	60.16N	lon. 11.04E
Forel. lat.	51.28N	lon. 1 24E
	111.44	9.40
		60
Mid. lat.	56.52	
	× lat.	580

Ex.

Example 2d. Required the mid. latitude between Island St. Helen, in latitude 16 00 S. Longitude 6 W. and Ascension island in latitude 7 .40 S. and longitude 14 .25 W.

St. Helena Latitude	16 .00 S.
Ascension Latitude	33 .46
Middle Lat.	33 .46
Middle Lat.	11 .50

From the latitudes and longitudes then given, the bearings and distances are easily found. Then in these examples North Bergen will be found to bear from Northforeland, N. 16 31 easterly, distance 5[illegible] miles; and in example 2d. Ascension bears from St. Helena N. 40 27 westerly the dist. 625 miles found by middle latitude, and by mercator I find their bearings and distances the very same as above, notwithstanding the variety of latitudes the greatest error in the bearing here is but 4 minutes of a degree and not one seventh of a mile in the distance which fully demonstrate, the common methods to be just, when the difference of latitude doth not exceed 8 or 9 degrees but when the difference of latitude is 10 degrees and upwards then recourse must be had to the table as in the following examples.

Required the middle latitude between Cape Clear in latitude 51 .10N longitude 10 .30 W. and Berbadoes in Latitude 13 .16 N. Longitude 58 .50 W.

Sum latitudes	64 .20	By
for 38d. ✕ of lat. add	6 .24	Table
Half this Sum	70 .44	
Is the M. latitude	35 .22	True

Longitudes	10 .30 W.
	52 .49 W.
	42 .19
	60
✕ of Long.	2539

Required the middle latitude between the Bay of Bulls in latitude 47 .50 N. and longitude 51 .[illegible] W. and the island St. Thomas in latitude 00 .00 and longitude 8 .20 E.

Bay of Bull latitude	47 .50
For 47 50 Add	10 .04
Half this Sum	57 54
Is the midle lat.	28 .57

From the given longitudes and latudes with the middle latitude thus found, the bearings and distances will be found nearly the same as by mercator, and shows the defect of the common rule.

By the Common Rule. St. Thomas bears from the Bay of Bulls S. 48 55 westerly; Distance 4347 miles.

2d. By the New Rule. Their bearing is S. 47 .35 westerly, and their distance 4256 miles.

3d.

3d. By Mercator Saling. Their courſe or bearing is S. 47 .36 weſterly, and their diſtance = 4256 miles; ſo that this new rule for middle latitude, agrees with mercator.

Caſe 2d. When one Place is in North Latitude, and the other in South, then one third of the ſame of both Latitudes is the middle Latitude.

Example. Required the middle latitude between the iſland Madera in latitude 32 .17 N. and 17 .26 W. and St. Helena in latitude 16.00 S and longitude 6 .14 W.

Their Sum is	48 .17		11 .12
			60
One third the ſum is the Mid. lat.	16 .06	× of Long.	6 .72

Example 2d. Required the middle latitude between cape St. Vincent, in latitude 36 .53 N. and Longitude 9 .06 W. and Cape Horn in latitude 57 58 S. and longitude 79 .51 W.

Cape St. Vincent	36 .53 N.	× of Lat.	94 .51	9 .06 W.
Cape Horn	57 .58 S.		60	79 .51 W.
Sum	94 .51	× lat.	5691 miles	70 .45
				60
One third the M. l.	31 .37	× Long.		4245

This Example is wrought after the ſame manner as example third in midde latitude before going.

Yet you muſt note that when the exceſs or difference of latitude is under 10, and the ſum of both latitudes under 90 .00 ſubtract duble the number of minutes that the difference of latitude conſiſts of degrees, from the middle latitude (thus found) for the true middle latitude, but if the ſum of both latitudes exceeds 90 .00 Subtract it from 180 .00 and double the number of the remaining deg. for minutes. Subtract it from the middle latitude thus found gives the true middle latitude. Except when the exceſs of lats. are upwards of 22 deg. add to the common middle lat. thus found, the degrees and minutes againſt the exceſs in the foregoing table for the true middle latitude

Required the middle latitude beween the iſland Madera in latitude 32 .44 N. and longitude 17 .26 W. to the Cape of Good Hope latitude 19 .35 E.

From

From one third their ſum 66 .51	= 22 .17	Sum 37 .01
Subtract twice 67 min. or	2 .14	60
Remains 20 .03 the true M. lat.	20 .03	× Lon. 2221 ms:

Required the middle latitude between the Lizard in England, in latitude 49 .50N. and longitude 5 .14W. Cape Horn in lat. 57 .58 S. and longitude 79 .55 W.

This ſum is	107 .53	one third is 35 .57	Long.	5 .14 W
Subſtract from	180 .06			79 .55 W
Remains	72 .07	and 72 × 2 = 2 .24		74 .41
				60
		Remains the true middle Lat. 33 .33		448.1

Required the middle latitude between the Eaſt entrance of the Straits of Megellan latitude 51 .58 S. and longitude 75 .05 W. and Cape Verd lat. 14 30 N. and longitude 17 .20,

Sum of lat. 66 28 one third thereof	22 .09	× Long.	57 .45
For 37 half degrees exceſs of lat. add	6 .15		60
The true middle latitude is	28 .24		3465 ms.

Required the middle latitude between the S. E. part of Japan, in latitude 39 .10 N and longitude 135 .15 E. and Madagaſgar in latitude 12 .10 S, and longitude 55 .24 E.

To one third of the Sum	51 .20
37 degrees exceſs, add	3 .25
	3) 54 .45(18 .15 True Middle Lat.

NAVIGATION INSTUMENTALLY.

MY intent in this ſection is to ſhew how all the caſes in Plain ſailing, Mercator ſailing, Middle latitude, and Parallel ſailing, may be done inſtrumentally by ſcale and compaſſes, and Martin's ſliding rule, or ſcale; they being inſtruments ſo common and expeditious, for inſtrumental operation, that few that are deſirous of improving themſelves in the knowledge of Navigation, go to ſea without them. In order to the right underſtanding of which, it is neceſſary, firſt, to give

give a deſcription of that part of the ſcale which ſerves for our preſent purpoſe, and then proceed to the uſe of it.

The firſt line next the top commonly marked S. R. is the fine rhumb, and is numbered 1, 2, 3, 4, 5, 6, 7, and ends at the braſs nail with 8, which is Radius, by reaſon that 8 rhumbs or points of the compaſſes is a quarter of the whole circle, therefore = 90 .00 degrees. The next line marked T. R. is the tangent rhumbs, and this line is numbered 1, 2, 3, and at the braſs nail 4, the tangent of four points, or 45 degrees, being equal to Radius, and then proceeds backwards to the left hand, with 5, 6, 7, the tangent of 8 points, 90 degrees, being infinite.

The fine rhumb or tangent rhumb, being only the fine or tangent of the degrees and minutes, anſwering to theſe rhumbs thus, 1 point of the compaſſes containing 11 .15 m. therefore the fine of 1 point, is = the fine of 11 .15 &c. and 3 points are equal 33 .45, therefore the fine of 3 points in the fine rhumbs, is exactly againſt the fine of 33 45 in the fines, and the tangent of 3 points, is right againſt the tangent of 33 .45 &c.

The next line being the third in order marked (Numb.) is the line of numbers, which is numbered from the left hand with 1, 2, 3, 4, 5, 6, 7, 8, 9, the diviſions at 1, 2, &c. being the greateſt and growing leſs towards 90 &c. theſe diviſions being each devided into 10 equal parts, and every one of theſe ſub divided (wherever it will permit) into 10 parts, and are thus read, if you call 1 at the left hand 1, then the next 2 is 2, and ſo on 3, 4, 5, &c. to 9, and the 1 in the middle is 10, and the next 2, 3, 4, &c. are 20, 30, 40, &c. and the 10 at the right hand is 100, and then when 1 in the middle is 10, and the 2 is 20 &c. then every one of the 10 leſſer diviſions between one and two is one, then one being 10, the next ſmaller diviſion is 11, and the next 12, where there is commonly a braſs nail, and ſo on to 13, 14, 15, &c. till you you come to the 2 for 20, and 3 for 30, and ſo in the reſt.

But if you make one at the left hand 10, then one in the middle is 100, and one at the right hand is 1000, and then every one of the leſſer diviſions which was counted one is now reckoned ten, &c. then the one at the middle being one hundred, the next ſmall diviſion (which before was called eleven) is now 110 and 10, and the next where the braſs nail, is one hundred and twenty &c and then every one of the ſmalleſt diviſions is called one; then ſuppoſe I would find one hundred and twenty-five on the ſcale, I call 1 in the middle or at the left hand one hundred, or counting two of the ſmall diviſions further, (which is juſt at the braſs nail) and then five of the ſmall diviſions, thus I hold my compaſſes, it being the number required. A little practice will make it eaſy.

The

The next line is the fines, and marked at the right hand (fine) and numbered from the left hand 1. 2, 3, 4. 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70. 80, 90; the longer ſub diviſions between 10 and 20, and between 20 and 30 &c, being each 1 degree; but the degrees under 20 are ſubdivided into 6 parts, each part being 10 minutes, and where the degrees is divided in 4 parts, each part is 15 minutes, &c. Then ſuppoſe I ſeek the fine of 23 .30; firſt I find 20, and count 3 of the diviſions for 30 minutes, for the degrees are divided into 4 parts, and that is the point repreſenting the fine of 23 .30, where there is commonly a braſs nail, as at 12 on the line of numbers.

The next line is verſed fines marked (V. fines) of which there is ſeldom uſe made in Navigation.

The next is tangents, marked at the right hand (Tang.) they proceed from the left hand to the right from 1 to 45, and then back to the left hand, toward 90 .00 the diviſions are underſtood in all reſpects as thoſe of the line of fines, and needs be no further explained. By this ſcale and a pair of compaſſes, may be performed all the propoſitions in trigonometry and Navigation, in all thoſe parts as they are ſolved before in this treatiſe, by Geometrical conſtruction and by Trigonometrical and Arithmetical calculation; here I ſhall ſhew how they may be ſolved by Inſtrumental operations, both by ſcale and compaſſes, and MARTIN's ſliding ſcale or rule; and here what ever the queſtion be, the proportion for anſwering it is the ſame, as in Trigonometry, by logarithm fines and tangents; only whereas in natural numbers the operation is performed by multiplication and diviſion, when three numbers are given to find a fourth and in logarithms, it is done by addition and ſubtraction, ſo here its performed by taking in your compaſſes the diſtance on the ſcale, between the firſt and ſecond terms, and the ſame extent will reach from the third given term, to the fourth term required.

Or by the ſliding rule or ſcale, ſet the firſt term on the ſlider to the ſecond term on the rule, then againſt the third term on the ſlider, you will have the fourth term on the rule, and if the ſecond term have the ſame proportion to the firſt that the fourth hath to the third, then the third will have the ſame proportion to the firſt, as the fourth is to the ſecond, and when the firſt and the third terms are both of one denomination, viz. both fines, or both tangents, or both numbers, as it happens in moſt queſtions in Navigation, and where the ſecond and fourth are of one denomination, I would rather adviſe to extend from the firſt to the third, and ſo you keep along one line, whether fines, tangents or numbers, and ſo the proportions and anſwer, will come out the ſame.

And becauſe the proportions in this manner of working, are the ſame as in logarithmetical operations, I ſhall not take the trouble of running

ning over all the cases in plain mercator and middle latitude, as in the foregoing parts thereof, but shall only instance on some few questions, and thereby shew the young Navigator, how all the rest may be performed by the examples before delivered in the trigonometrical part.

Case First in Plain Sailing.

The course and distance being given, to find the difference of latitude and departure.

Suppose a ship sails N. W. by N. 123 miles; I desire to know her difference of latitude and departure.

The Proportion in the Trigonometrical parts, are

As Radius: Is to the Distance:: So is Sine Course: to the departure.

Then by Scale and Compasses.

Extend the compasses from radius or S. rhumb, to S. 3 points, that extent from 123 on the line of numbers to the left hand, will give 68 the departure required.

Again, Extend the compasses from S. 8 points, or 90 00 on the S. Rhumb to S. 5 points or 56 .15, that extent laid from 123, to the left hand on the line of numbers, will give 102 the difference of latitude required.

By The Sliding Rule, for the Departure and Difference of Latitude.

As Radius 90 .00: to Dist. 123:: S. 33 .45: to Departure 68.
As Radius 90 .00: Dist. 123:: S. 56 .15: difference of lat. 102.

Set 90 .00 the first term on the slider to 123 the distance on the rule, then against S. 33 .45 on the slider you will have 68 the dparture on the rule, and also against 56 .15 on the slider, you will have 102 the difference of latitude on the rule.

By Inspection, in the Traverse Table:

Find the course 3 points at the top of the table in difference of latitude and departure, then against 123 the distance in the first column, and under latitude stands 102 the difference of latitude, and under departure stands 68, the departure which was required.

Case 2d. The Course and difference of Latitude given, to find the Distance and Departure.

Suppose

Suppoſe a ſhip ſails N. E. by N. until ſhe makes her difference of latitude 102 miles; required her diſtance and departure.

By Scale and Compaſſes. A General Rule.

Extend the compaſſes from the firſt term to the third, and that extent laid the ſame way from the ſecond, gives the fourth, the anſwer required.

That is, extend from S. 56 .15 on the line of ſines, to 102 on the line of numbers, that extent the ſame way from S. 90 .00 will give 123 on the line of numbers the diſtance; and the ſame extent laid from 33 .45 on the ſines the ſame way, will give 68 on the line of numbers, the departure required.

By the Sliding Rule. A General Rule.

Set the firſt term on the ſlider to the ſecond term on the rule, then againſt the third term on the ſlider, you will have the fourth term on the rule; that is ſet 56 .15 on the ſlider to 102 on the rule; then againſt 90 .00 on the ſlider, you have 123 the diſtance on the rule; then againſt 33 .45 on the ſlider, you will have 68 on the rule; the departure required.

Caſe 3d. The Courſe and Departure being given, to find the Diſtance and difference of Latitude.

Suppoſe a ſhip ſails S. E. by S. until her departure be 68 miles; required her diſtance and difference of latitude?

I having in the foregoing work, ſufficiently applied the uſe of the ſcale and compaſſes, I ſhall now only ſhew the uſe of Martin's ſliding rule.

Set S. 33.45 on the ſlider to 68 on the rule, then againſt S. 90.00 on the ſlider you will have 123 on the rule, for the diſtance; and againſt 56 .15 on the ſlder, you will have 102 on the rule the difference of latitude required.

By the Table of difference of Latitude and Departure.

Seek for 3 points at the top of the table, and in the Column under dep. at the top, look for 86 or neareſt to it, and againſt it in the firſt column under diſtance you have 123, and under the column Lat. you will have 102, the difference of latitude required.

Caſe

Case 4th. The Distance and difference of Latitude given, to find the Course and Departure.

If a ship sails in the S. E. quarter until her distance be 123 miles, and her difference of latitude 102 miles; required her course and departure?

By MARTIN'S *Sliding Rule.*

Set S. 90 .00 on the slider to 123 on the rule, then against 102 on the rule, you will have 56 .15 on the slider for the S. C. Course, and against 33 .45 the S. Course on the slider, you will have 68 on the rule, the departure.

By the Table of difference of Latitude and Departure.

Seek for 123 in the column of distance, and run over the several columns of your table, for 102 in one of the other columns against it, which being found, observe where you find the title (Lat.) whether at the top or bottom of the table, for there you find also the course, which in this example is 3 points, or S. W. by S. and departure 68.

Case 5th. The Distance and Departure being given, to find the Course, and difference of Latitude.

Suppose a ship sails in the N. W. quarter until her distance be 123, and departure 68 miles; required her course and × of latitude.

By MARTIN'S *Sliding Rule.*

Set S. 90 .00 on the slider to 123 the distance on the rule, then against 65 on the rule, you will have 33 .45 on the slider the S. Course, and against 56 .15 the S. C. Course on the slider you will have 102 on the rule for the difference of latitude.

By the Table of difference of Latitude and Departure.

Seek for 123 in the column of distance and against it run over the table till you find 68 for the departure, and at the top of the table over it you find three points for the course, and 102 for the difference of latitude

Case 6th. The difference of Latitude and Departure being given, to find the Course and Distance.

Suppose

BIBLIOTHECA BODLEIANA OXON.

Suppoſe a ſhip ſails in the S. W. quarter until her difference of latitude be 102 miles, and departure 68 miles; required her courſe and diſtance?

By MARTIN's *Sliding Rule.*

Set 102 one the ſlider to 68 on the rule, then againſt 45d. on the ſlider, you have tangent 33 .45 on the rule for the courſe; then ſet S. 33 .45 on the ſlider to 68 on the rule, then againſt S. 90 .00 on the ſlider, you will have 123 on the rule, the diſtance required.

By the Table of difference of Latitude and Departure.

Seek through the columns of difference of latitude and departure, till you find 102 againſt 68, and over them you find 3 points, or 33.45 for the courſe; and againſt it in the column of diſtance you find 123, the diſtance required.

How to find the difference of Longitude by the Table of difference of Latitude and Departure.

IF we have one latitude, courſe, and diſtance given, or both latitudes and courſe &c. the reſt are found by Plain Sailing, then find the middle latitude, always obſerving this caution, to make a latitude rather too big than too little, where the middle latitude cannot be had exactly without a remainder, or fraction. This is the general rule.

Find the complement middle latitude amongſt the degrees at the top of the table, or at the bottom, and under it, (if you find it at the top or above it if you find it at the bottom) in the column of dep. find your departure, and right againſt it in the column of diſtance is the difference of longitude.

And altho' this method is not ſo practicable in great numbers, yet it is very uſeful at ſea, for working a days run, which is ſeldom above 50 or 60 leagues, and therefore I ſhall recommend it to the Navigator, as the moſt expeditious method and of ſufficient exactneſs for ſhort diſtances; there being methods ſufficient laid down in this treatiſe for more exactly correcting the reckoning once or twice in a week, but if you think it too much trouble to ſubtract the middle latitude from 90 .00 to find its complement, you may find the mid. lat. amongſt the degrees as before, and find the departure in the column of difference of latitude, and againſt it in the column of diſtance ſtands the difference of longitude.

I ſhall

I shall give an example or two, and refer the the young Navigator for further practice of this method, to the examples laid down in keeping a reckoning, as will appear further on in this Book, where I shall illustrate by examples, and shew its general agreement with the longitude as found by mercator sailing.

Example 1st. If a ship in latitude 55 .01 N. sails in the N. E. quarter into latitude 56 .10 N. making her departure 50 miles; required her course, distance, and difference of longitude?

Lat. come to	56 .10	56 .10	Middle lat.	55 .35
Lat. dep. from	55 .00	55 .00		
			Co. mid. lat.	34 .25
✕ of Lat.	1 .10	111 .10		

Difference of lat. 70 : T. R. 45 : : Dep. 50 : T. C 36 .00 nearly

S. C. 36 .00 : Dep. 50 : : Radius 90 .00 : distance 86 miles.

Having found the course N. 36 .00 easterly, distance it be 86 miles, and complement middle latitude 34 .25 or let it be 35 deg.; find the complement middle latitude at top of the table, look under it in the column of departure, and you find 49 .50 the nearest number to 50, against which in the column of distance, you find 59 the difference of Longitude required.

Example 2d. Required the course, distance, and difference of longitude; one is latitude 56 .15 N. the other in latitude 58 .35 N. their difference of meridians 51 miles.

Latitudes	58 .35	✕ lat.	: T. R.	: : ✕ mer.	: T. C.		
	56 .15	140	45 .00	51	30 .00		
✕ of Latitude	2 .20 = 140 m.	30 .00	: 51	: : 90 .00	: 162		

Here the course is foudd = 30 degrees from the meridian, the middle latitude is 57 .25, but we must call it 58, which found in the degrees, there is not such a number as 81 in the column of latitude, therefore find its half = 40 .5, or the nearest to it, which is 40 .3 and against it in the column of distance, you find 76, which doubled is 152 the difference of longitude required.

To find the Difference of Longitude by Mercator, in the table of difference of Latitude and Departure.

This is the generally practised by the officers in the Royal Navy, in keeping their journals.

Lat.

Latitude	58 .35	M. P.	4361
Latitude	56 .15	M. P.	4101
	Meridian difference of Latitude		260 miles.

The course found as before = 30 .00 degrees from the meridian.

Then find the meridian difference of latitude in the column of latitude for that course, and no such number can be found, but dividing 260 by 10 miles = 26, which look for under the course 30 .00 you will find its departure = 15, which multiplied by 10 gives 150 for the difference of longitude required, which differs only two miles from that found by middle latitude.

Example. 3d. Suppose a ship sails in the N. E. quarter from latitude 51 .17 N. and longitude 27 .31 W. making her distance 280 leagues, and difference of meridians 277 leagues; required her course, distance, and difference of longitude?

The course found by Plain Sailing is N. 18 .40 easterly, difference of latitude 191 leagues = 9 .33.

Lat. departed from	51 .17N.	Latitudes.	60 .50	M. P.	4629
✕ of latitude	9 .33N		51 .17	M. P.	3596
Intitude come to	60 .50N.	Meridian ✕ of latitude in miles			1033
		or = 344 leagues one mile.			

Now to find the difference of longitude by mercator, in the table of difference of latitude and departure, and since the meridian diff. of latitude cannot be found in the table, you may call it 34.4 or nearest to it which is 34.1 against which in dep. stand 39,2 which multiplied by 10 makes 392 leagues the difference of longitude required.

Again, to find the difference of longitude by middle latitude, in the tables of difference of latitude and departure, the complement middle latitude is found = 34.3 or 35 degrees, by taking the greater degree, then seek for 277 the difference of meridian, in the table under 30 degrees, in the column (dep.) but 277 cannot be found, but calling it 27.7 and the nearest to it in the table is 27.8, which is too little, but next greater 25.3 in the column dep. then against it in the column of distance stands 39, which multiplied by 10, makes 390 leagues, the difference of longitude required.

THE

THE

Gregorian Kalender.

THE Julian Kalender ceaſed, and the new account took place the firſt of January 1752, and in September following, the 11th day were adjuſted by calling the 3d. day of that month the 14th. and continuing the reſt in their order.

There are three leap years to be abated in every four centuries, how to find in what century the laſt year is to be a leap year, and in which it is not; cut off the two cyphers and divide the remaining figures by 4 if (0) remains, the year is a leap year, but if any thing remains it is a common year.

Eample 1ſt.	Example 2d.	Example 3d.	Exam. 4th.	Exam. 5th.
4)18|00(	4)19|00(	4)20|00(	4)21|00(	4)22|00
4—2	4—3	5—0	5—1	5—2

Hence it appears that Examples 1, 2, 4, and 5. are common years, by reaſon of having remainders, but the 3d. having no remainder is a leap year of 366 days. With regard to any other years, note Mr. Street's diſtichs or memorial verſes, ſo far as they are agreeable to the New Stile, are here inſerted.

PROBLEM. I.

To find what Year is Leap Year, Obſerve this Rule.

Divide the year by 4, what's left ſhall be
For Leap Year (0), what's paſt, 1. 2, 3.

Examples, The years 1772, 1773. 1774, 1775, 1776, whether are they leap years or common years.

4)1772(
443—0 L. Y.
Anſwer

4)1773(
443—1 com year

After the ſame manner the reſt are found, as

1772 —— is Leap Year
1773 firſt after Do.
1774 ſecond after Do.
1775 third after Do.
1776 is Leap year.

PROB-

PROBLEM. II.

To find the Dominical Letter or Sunday Letter for any Year, this is the Rule.

Divid the year, and a fourth of it by 7,
What's left from 7, the letter is given.

Difinition. The week days in the kalenders are expreſſed by the firſt ſeven letters in the alphabet, and one of them is a dominical letter.

Secondly, the dominical letter is that which ſtands for and is commonly called ſunday.

Note, When it is leap year, there are two dominical letters, it is the latter of them that this rule finds, the former ſerves till the end of February, and the latter of them from thence till the years end.

Indices,	1.	2.	3.	4.	5.	6.	7.
Letters	A.	B.	C.	D.	E.	F.	G.

Example. I deſire to know the dominical letters for the years of our Lord 1772, 1773, 1774, 1775, 1776, and 1777?

1772 Year Given
443 One fourth of it

7)2215

316—3 Remains 3 which ſubtract from 7 remains 4 the letter. But being L. Y. has 2 letters E. D.

Note, alſo the dominical letter goeth backwards in every common year one letter, but in leap year two letters from that in the foregoing year; after the ſame manner of working is the dominical letter found for all the other years.

1772, 1773, 1774, 1775, 1776, 1777 — The Dominical Letter is { E D / C / B / A / G F / E } The Anſwer as was required.

PROBLEM. III.

To find the Golden Number, Circle of the Sun, and Roman Indiction, for any Year.

Difinition. The golden number is a period of 19 years, the uſe of this circle is to find the change of the moon, becauſe after 19 years, the

the change of the moon falls on the same days as in the former 19 years, though not on the same time of day, there being an anticipation of near an hour and a half.

The Rule } When 1, 9, 3, to the year hath added been,
Divide by 19. 28, and 15.

That is, to find the golden number, add 1 to the year of our Lord, then divide the sum by 19, the remainder is the golden number, if (0) remains 19 is the golden number.

Examples. Required the golden number or prime, for the years of our Lord 1772, 1773, 1774, 1775, 1776, and 1777.

1772 19)1773(93
1 171
1773 63
57
Rem. G. N. 6

1772
1773
1774
1775
1776
1777
} Golden Number is { 6, 7, 8, 9, 10, 11

After the same manner the golden numbers are found for the rest of the years.

PROBLEM IV.

By the Golden Number or Prime, to find the Epact for any Year.

Definition. The epact is 11 days, that the year of the moon is lesser than the sun's year, the year of the moon being 354 days, and the year of the sun 365 Days; Note the epact never exceedeth 30 days, and alters every year eleven days, and is used to find the moon's age, and Easter day.

The Rule } Take one from the Golden Number,
Divide the remainder by 3;
For each one left add 10
Thirty reject, the prime make epact then.

That is, when one has been taken from the golden number, divide the remainder by three, and if one remains add ten to the dividend, and the sum will be the epact, if two remains add twenty, and if (0) remains the dividend is the epact required.

Rule 2d. Which is the same in effect, subtract one from the golden number, and multiply the remainder by eleven, and divide the product by thirty, and the remainder is the epact required.

Examples. I desire to know the epact for the years of our Lord 1772, 1773, 1774, 1775, 1776, and 1777?

G. Num.

G. Num. 6	1772		25	
1	1773		6	
	1774	The Epact is	17	The Answer required.
Remains 5	1775		28	
	1776		9	
30)55(1	1777		20	
30				
Epact 25				

After the same manner is found the epact for the rest of the years as above.

PROBLEM V.

To find the Age or Change of the Moon by the Epact.

To Janus 0, 1, 2, 3, 4, 5, 6,
8, 8, 10, 10, those to the epact fix,
The sum abate 30, to the month day add,
Or take from 30, age or change is add.

That is, if the epact for the year, the number of the months (taken as the stand in the verses above) and the day of the month added, rejecting 30, the moon's age, or take the sum of the epact and number of months from 30, will give the day of the moon's change in that month; Note, the number of months as they stand in memorial verse above, are January 1, February 2, March 1, April 2, May 3, June 4, July 5, August 6, September 8, October 8, November 10, December 10.

August 1st. 1772, Required the Moon's age,		December 25 1772, I desire to know the moon's age,	
Month day	1	Month day	20
Epact	25	Epact	25
Number of months	6	Number of months	10
Their sum is	32	Their Sum	60
Subtract	30	Subtract	60
Remains moon's age	2	Remains moon's age	0

PROBLEM VI

To find the Moon's Southing, and full Sea or high Water at any Place.

The Rule. Multiply the moon's age by 4, and divide the product by 5, and the quotient is her southing. N. B. when the moon's age exceeds 15, subtract 15 from it and work with the remainder, when you divide 5 what remains is so many times twelve minutes, which add

to the hours of the ſouthing, then to the moon's ſouthing thus found, add the time of full ſea on the full and change day, the ſum abating twelve (if it exceed) the time of full ſea or high water as required.

Auguſt 10 1772, I deſire to know the time of high water at Whitehaven, Workington, Dublin, Waterford, Newcaſtle, Cork, London, Dover, Hull and Briſtol.

Month day	12	Flows full and change at Whitehaven.	10	.30
Epact	25	Moon's ſouthing	10	.24
Number of months	6			
Sum	43	High water 9 o'clock	8	.54
Subtract	30			
Moon's age	13	Flows full and change at Dublin 10.30 the ſame as at Whitehaven.		
	4			
	5|52	Flows F & C. Workington	11.	00
Moon's ſouthing	10—24	Moon's ſouthing	10.	24
		High water	9	.24
F. and C. at Liverpool	11 .30	F. and C. at Newcaſtle	05	.15
Moon's ſouthing	10 .24	Moon's ſouthing	10	.24
Time of High water	11 .54	Time of High water	3	.39
F and C. at London	3 .00	Full and change at Dover	00	.00
Moon's ſouthing	10 .24	Moon's ſouthing	10	.24
Time of High water	1 .24	Time of High water	10	.24
Full and change at Cork	4 .30	F, and C. at Waterford	4	.30
Moon's ſouthing	10 .24	Moon's ſouthing	10	.24
Time of High water	2 .54	Time of High water	2	.54
Flows F. and C. at Hull	6 .00			
Moon's ſouthing	10 .24	High water at Briſtol being at the ſame time as Hull		
Time of high water.	4 .24			

A Tide

A TIDE TABLE *in Alphabetical Order.*

A

	H.	M.
ABERDEEN	0	45
Army	1	30
St. Andrews	2	15
Amſterdam	5	00
Azmentiors	3	00
Arbroth	3	15
Antwerp	6	00
Archangel	6	00
Abermerith	6	00
Amozens river in St. Anns	6	00
Aldbrough	9	45

B

Brachy	0	00
Bajador in Barbary	0	00
Btactail Bracon	0	15
Blackneſs	1	30
Berwick	1	30
Bluet without	2	15
Br tain South Coaſt	3	00
Biicay coaſt	3	00
Bourdeaux river	3	00
Buchaneſs	3	00
Bona E' Sperance	3	00
Belliſle	1	30
Breaſt	3	45
Baſs without	3	45
Bourdeaux River	3	45
Brovage w:hout	3	45
Baltimore	4	30
Brec Sound	4	30
Breeman	6	00
Blackney	6	00
Briſtol	6	00
Briſtol Quay	6	45
Bridy water	7	45
Cape Blanco	9	45
Bulloigne	11	00
Race of Blanket	12	00

C

	H.	M.
Cape Cantin in Barbary	0	00
Calais without	1	30
Camfere	1	30
Coquet	2	15
Cape Clear in Ireland	4	30
Cork in Ireland	4	30
Caldy	5	15
Carnarvan Bay	5	15
Cromer	7	00
Caſket's without	8	15
Cape Sierrelion in Guiney	8	15
Chanderneſs	9	45
Cowes	10	30
Caen in the Feſs	10	30
Calais Road	10	30
Caiſhot	11	15
Condado	12	00

D

Dunkirk	0	00
Dover peer	0	00
Port Deſire in America	0	00
Downs	1	30
Dundee	2	15
Denby	2	15
Dort	3	00
Dunbar	4	30
Dungarvan	4	30
Dartmouth	5	15
St. David head	6	00
Dublin in Ireland	10	00
Dunnoſe	9	45
Dicpe	10	30
Dunwich	9	45
Dungerneſs	9	45
Dover	10	30

E

Emden	0	00

Elder

	H.	M.
Elder	0	00
Elve	0	00
Enchuyſen	0	00
Edam	1	30
Edinburgh	4	30
Egmont	4	30
Exwater	7	30
Entrance of the Emes	7	30

F

Flanders coaſt	0	00
Fluſhing	0	45
Finmark coaſt	1	30
Foutnoy without	2	15
Flamborough head	3	00
Fair iſle	3	00
Frith	4	30
Falmouth	4	30
Fern	5	15
Foy	5	30
Foulneſs	5	40
The Fly	7	30
Frieſland coaſt	7	30
Florida in Carolina	7	30
Foreland, north and ſouth	9	45
Firth	10	30
Fair iſle Roads	11	15

G

Gibralter road	0	00
Graveling	0	00
Guernſey	1	30
Goree	1	30
Graveſend	1	30
Galicia	3	30
Gaſcoin	3	00
Groyn	3	00
Gorrone mouth	11	11

H

Hever	0	00
Hern	0	00
Holy iſland	1	30
Hartley pool	3	00
Huncliff foot	3	45
Humber without	5	15
Holms	6	00
Hull	6	00
Hamburgh	6	00
Hague	8	15
Harlem	9	00
Havere de Grace	9	00
St. Helens	10	30
Harwich	11	00

J

Jutlanland Iſles	0	00
Ireland Weſt Coaſt	3	10
Ireland South Coaſt	5	15
John de Luce	10	50

K

Kentiſh Knocks	0	00
Killiars	3	00
Kinſale in Ireland	4	30
Kilduyn	7	30

L

Liſbon	2	15
St. Lucas	2	15
London	3	00
Leith	4	30
Lawreneſs	4	30
Lyn without	5	15
Lanion	5	15
Lundey	5	15
Lyn	6	00
London Derry	6	00
Landſend	7	30
Lizard	7	30
Lambay	8	15
Leyſtaff	9	45
Lenow	9	45
Liverpool	11	30
Lancaſter	11	00

M

Maze within	0	45

Maldon

	H.	M.
Maldon	0	45
St. Mark	2	15
St Mathew point	3	45
Mounts Bay	4	30
Milford	5	15
Moonlefs	5	15
St Maloes	5	15
Magnus ſound	8	15
Macknels caſt.	8	15
Iſle of man	9	00
Marget road	11	15

N

Newport in the Iſle of wight	0	00
Nore, Weſt end	0	00
North Cape Maggero,	3	00
Nants river without	3	00
Newcaſtle	5	15
St. Nicolas in Ruſſia	6	45
Needles	9	45
Normandy Coaſt	10	30
Naze	11	15

O

Orkneys	3	00
Orwell	9	00
Orfordneſs	9	45

P

Portſmouth	0	00
Poictou South Coaſt	3	00
Pens	3	00
Perthus	3	00
Portugal Coaſt	3	00
Plymouth	6	00
St. Powles	6	00
Podeſemsk, in Ruſſia	6	45
Portland	8	15
Peterport	8	15
Picardy Coaſt	10	30

Q

Queenborough	00	00
Quebeck in Canady	6	00

R

	H.	M.
Rebdan	0	45
Rocheſter	0	45
Rumney	1	30
Ramkins	1	30
Robin Hood's Bay	3	00
Rotterdam	3	00
Rovain	3	45
Rochel without	3	45
Roan River within	3	45
Ramſey	5	15
Rye	11	15
Rhodes	11	15

S

Shoe	0	00
Sheerneſs	0	00
Sleeve	0	00
Southamton	0	00
Spits	0	00
Shetland	3	00
Silly	3	45
Scarborough	3	45
Sound	3	45
Staples	3	45
Severn	4	30
Seven Iſles	4	30
Stockton	5	15
Spurn	5	15
Salcomb	6	00
Start	6	45
Sedmouth	6	45
Selberg	9	00
Seven cliffs	9	00
Shoram	9	15
Seynhead	10	00
Senegall	10	30

T

Tervere within	0	45
Tenet	1	30
Tervere without	1	30
Tinmouth	3	00

Teeſmouth

	H.	M.
Teesmouth	3	00
Teneriff	3	00
Torbay	5	15
Texel	7	30
Torgon	9	45

U

Urk	0	00
Use	3	00
Ushant without	6	00
St. Vallery	10	30

W

Isle of Wight	0	00
Winchelsea	0	45
Weilands	1	30
Whitby	3	00
Waterford in Ireland	4	30
Whitehaven	10	30
Workington	11	00
Weymouth	6	00
Wells	6	00
Weymouth Quay	6	45
Workingham	7	00
Winterton	9	00

Y

Youghall in Ireland	4	30
Yarmouth Road	8	15
Yarmouth peer	9	00
Yarmouth Town	9	45
Yarme	6	45

Z

Zealand Coast	1	30
Zeriok Sea.	3	00

The use of this table is the same as in other tables, for when you desire to know the time of high water at any place mentioned in it, you need but look in the letter that the name of the place begins with, and you have what time it flows on the full and change days, to which add the moon's southing, gives the time of high water at any time.

To work an Observation, or to find the Latitude of the Place by the Table of the Sun or Stars Declination, and their Zenith, Distance, &c.

WHEN you take an observation by a common sea quadrant, the degrees and minutes that your sight vain stands at, being added to the degrees that your slider or glass vain stands at, will give the zenith distance or complement of the meridian altitude, with which, and the declination found in the tables, you may find the latitude as follows.

First. Take notice whether the sun or stars be to the northward or southward of you, at the time of observation; if they are to the northward, call your zenith distance north, or if they are to the southward, call it south,

Secondly,

Secondly, if the zenith distance and declination are both north or both south, subtract the less from the greater the remainder will be the latitude you are in of the same name with the declination, if that be greater than the zenith distance otherwise of a contrary name.

Example 1st. Being at sea on the 23d. of August 1772, and had on my quadrant 45 .17 and the sun, to the southward of me; I desire to know what latitude I am in?

The Operation.

Sun's zenith distance	45 17 S
Sun's declination	11 14N
The latitude observation	56 31 N

The latitude of any place is the nearest distance between the equinoctial and the zenith of that place, the sun's declination is the sun's nearest distance from the equinoctial, and the sun's distance from the zenith of the place, is the zenith distance or complement of the sun's altitude, now if to o z the zenith distance you add o Æ the sun's declination the will be Æ z the latitude of the place of observation. Pl. II. Fig. 91

Hence it appears that if the sun be to the southwards of you, and hath north declination, you must add the declination to the zenith distance, and the sum is the latitude of the place of observation north.

Variety 2d. The sun being between the equinoctial and the horizon that is, when the sun is to southward of you and hath south declination, the rule is, subtract the declination from the sun's zenith distance; the remainder is the latitude north.

Example. November 27th, 1772. by observation with quadrant. as the sun's zenith distance is found to be 67 .31 S. I desire to know the lat. of the place of obs.

Sun's zenith distance	67 .31 S.
Sun's delination	21 .19 S.
Remain lat. of Obser.	46 .12 S

Note, But when the declination is more than the zenith distance, then subtract the zenith distance from the declination, the remainder is the latitude the ship is in south.

Example 3d. January 2d, 1772. By observation with a quadrant or forestaff, I find the sun's zenith distance 13 17 S, required the latitude of the place.

Sun's declination	22 57
Sun's zenith distance	13 17
Latitude by observation	9. 40 S

If the sun be to the northwards of you and hath south declination, you must then add the sun's declination to the zenith distance, the sum is the latitude you are in south.

December 11th, 1772.
If the ſun's zenith diſtance be 27 .37 Northe ly, I demand the latitude of the place,

Sun's zenith diſtance	27 .17 N.
Sun's declination	23 .09 N.
Latitude Obſervation	50 .23 S.

If the ſun be to the northward of you and hath north declination, ſubſtract the declination from the zenith diſtance, the remainder is the latitude you are in ſouth, but if the declination be more than the zenith diſtance, ſubtract the zenith diſtance from the declination, the remainder will be the latitude you are in north.

Obſervations in South or North Latitude.

June 3d, 1772, ſuppoſe the ſun's zenith diſtance be 51 .19 to the northwards of me, I deſire to know what latitude I am in?

Sun's zenith diſtance	51 .19 N.
Sun's declination	22 .25 N.
Latitude obſervation as required	28 .54 S.

July 1ſt. 1772. Supoſe the ſun's zenith diſtance be 11 .19 north, I deſire to know the latitude the ſhip is in?

Sun's zenith diſtance	11 17 N.
Sun's declination	22 .10 N.
Latitude Obſervation as required,	10 .51 N.

Variety 4th. Is when the ſun is between the elevated pole and the horizon; that is, when the ſun or ſtar, comes to the meridian below the pole,

The General Rule.

Subſtract the complement of the ſun's declination from the zenith diſtance, the remainder is the complement of the latitude.

Or thus, add the zenith diſtance to the declination, and ſubtract that ſum from 180 .00, the remainder is the latitude of the ſame name with the declination,

Example 1ſt. Admit in a ſhip at ſea, on the coaſt of Greenland, I obſerve the ſun's meridional zenith diſtance at midnight to be 79 .57 north, the ſun's declination being then 20 .47 N. required the latitude of the place,

90 .00	
20 .47	
69 .13	

Sub. Co. declination	69 .13
From Z diſtance	79 .57
Remains Co. lat.	10 .44
Subſtract from	90 .00
Remains Latitude	79 .16

Example.

Example 2d. Of ſtars near the north or ſouth pole, that neither riſe nor ſet in high latitudes, and comes to the meridian twice in twenty-four hours, ſuppoſing a ſtar's zenith diſtance 42 .24 N. and its declination 87 .40N. It is required to find the latitude of the place of obſervation.

Zenith diſtance	42 .14 N.	
Declination	87 .46 N.	The projection is omitted, it being of the ſame ſort as the laſt figure.
Their ſum is	130 :00	
Subſtract from	180 .00	
Remains latitude	50 .00 N.	

Variety 5th. If the ſun or ſtars have no declination, that is if they are on the equinoctial the Zenith diſtance is the latitude contrary to its name.

Example 1ſt. A ſhip at ſea, March 21 or September the 23d. obſerves the ſun on the meridian to the ſouthwards of the zenith 50 .00 required the latitude the ſhip is in.

Here the ſun being on the equinoctial, and leaving no declination the zenith diſtance is the latitude required.

Variety 6th. If the ſun or ſtar be in the zenith, that is directly over our heads, the declination is the latitude of the ſame name with the declination, this is ſo plain that it needs no example

I have here omitted giving directions for projecting the foregoing ſchemes ſince they are ſo very eaſy, to protract, for having with a chord of 60, deſcribed a circle, and croſſed it right angles with zenith nadir and horizon.

II. Set off the ſun's zenith diſtance from Z towards H if it be ſouthward, or from Z towards O if it be northward.

III. If the ſun or ſtar hath north declination, the equinoctial muſt be ſet of to the ſouthward of the ſun, and if the ſun hath ſouth declination it muſt be placed to the northward of the ſun.

IV. The equinoctial being thus found draw through the center of the circle, the equinoctial E. Q; and croſs it at right angles with the axis N. S. then if you find the north pole appear above the horizon line H O, you are in north latitude, if the ſouth pole be above it you are in ſouth latitude.

N. B. The foregoing rules will ſerve to find the latitude by any of the known fixed ſtars, if you work with the complement of any known ſtars altitude or Zenith diſtance, when obſerved with a fore ſtaff, when the ſtar is on the meridian, to find which will be ſhewn in the uſe of the aſtronomical tables hereafter delivered.

RULES

RULES FOR LONGITUDE.

The Longitude of any two Places being given to find the difference of Longitude between them.

Rule. If the longitudes are both east or both west, subtract the lesser from the greater, and the remainder is the difference of longitude.

But if one longitude be east and the other west, then add them together, and their sum (if less than 180 degrees) will be the difference of longitude, but if it be more than 180 degrees, then subtract it from 360 and the remainder will be the difference of longitude.

Example 1st. What is the difference of longitude between Cape Finistere and Island Antigua?

Example 2d	Cape Finistere in longitude	09 .40 W.
	Antigua in longitude	61 .45 W.
	Difference of longitude	52 .05

What is the difference of longitude between Barcelona and the rock of Lisbon?

Example 3d.	Barcelona in longitude	02 .18 E.
	Rock of Lisbon in longitude	09 .50 W
	Difference of longitude	12 .08

What is the difference of longitude between the S. E. point of Japan and the island of St. Christophers.

S. E. point of Japan in longitude	140 .30 E.
St. Christophers in longitude	62 .40 W.
Exceeds 180 .00	203 .10
Subtract it from	360 .00
Remains the difference of longitude	156 .50

The Longitude sailed from, and the difference of longitude being given, to find what Longitude the Ship is in.

Case 1st. When you sail from east longitude to the eastward, or from west longitude to the westward, add the difference of longitude to

to the longitude ſailed from the ſum (if leſs than 180 degrees) is the longitude come to, of the ſame name with the longitude you ſailed from, but if the ſum be more than 180d. 0 m. then ſubtract it from 360d. 00 and the remainder will be the longitude you are come into, of a contrary name to the longitude you ſailed from.

Example 1ſt. A ſhip from longitude 51 17 E. ſails to the eaſtward, till ſhe makes her difference of longitude 397 miles, required the longitude ſhe is come to.

Example 2d.	Longitude departed from	51 17 E.
	Difference of longitude 397 miles =	6 37
	Longitude come to	57 .54

A ſhip from the longitude of 179d. 51 W ſails to the weſtward till her difference of longitude be 19 55 what longitude is ſhe come to.

Longitude	179 51 W
Diff. of longitude	19 50
Exceeds 180	199 46
Subtract from	360 00
Remains the longitude come to.	160 14 E.

Caſe 2d. When you ſail from Eaſt longitude to the weſtward, or from weſt longitude to the eaſtward, ſubſtract the difference of longitude from the longitude you departed from, and the remainder will be the long. come to, of the ſame name with the long. departed.

But if the difference of longitude be greater than the longitude departed from, then ſubtract the longitude you departed, from the difference of longitude, and the remainder will be the longitude come to, of a contrary name with the longitude ſailed from.

Example 1ſt. A ſhip ſails from longitude 57 .37 W. ſails to the eaſtward, till ſhe makes her difference of longitude 15 .54; Required what longitude ſhe is come to?

Longitude ſailed from	57 .37 W.
Difference of longitude	15 .54
Longitude come to	41 .43 W.

Example 2d. A ſhip from the longitude 37 .35 E. ſails to the eaſtward, till her difference of longitude is 81 .31; I deſire to know what longitude the ſhip is come to?

Longitude ſailed from	37 35E.
Difference of longitude	81 31
Longitude come to	43 36W

The

The Variation of the Compaſs.

To find the Variation of the Compaſs by an Amplitude.

THE true amplitude is to be found by tables as before taught, or by this proportion viz. As the ſine compliment of the latitude : is to the ſine of the ſun's declination : ſo is radius : to the ſine of the ſun's true amplitude, from eaſt to the northward at ſun riſing, if the declination be north or eaſt to the ſouthward, if the declination be ſouth, or if the amplitude be taken at ſun ſetting it will be weſt northerly, with north declination, and weſt ſoutherly when the declination is ſouth.

The magnetical amplitude is to be found by the compaſs at the time of the ſun's riſing or ſetting, and is ſo many degrees or minutes as you ſee, it riſe from the eaſt, or ſet from the weſt, either to the northward, or to the ſouthward, as for example, ſuppoſe being at ſea, I find by ſetting the ſun with my compaſs, that he riſes 10d. 15m to the northward of the eaſt, then the magnetical amplitude is E. 10 15 N or ſuppoſe I find by the compaſs that he ſets 14d 12m. to the ſouthward of the weſt, then the magnetical amplitude is W. 14 12 S.

Then if your true amplitude and magnetical amplitude are both to the northward or both to the ſouthward, ſubtract the leſſer from the greater, the remainder is the variation, but if one be to the northward, and the other to the ſouthward, add them together, and the ſum will be the variation.

Now having found how much the variation is, it remains in the next place to find which way it is, that is, whether it be eaſterly or weſterly.

Rule. If the amplitude be taken at ſun riſing, and the magnetical amplitude be farther from the north than the true amplitude is, then the variation is weſterly, but if it be nearer to the north it is eaſterly.

If it be taken at ſun ſetting, if the magnetical amplitude be farther from the north than the true amplitude is, then the variation is eaſterly, but if it be nearer to the north it is weſterly, as may be ſeen by the following example.

Example 1ſt. Auguſt 12th. 1772.

In latitude 54.37 N. the ſun's magnetical amplitude being E 12. 37 northerly at ſun riſing, I demand the variation of the compaſs?

90 .00	As S. C. latitude	35 .09	60 .00	
54 .00	Is to S. ſun's declination	14 .48	12 .37	
	So is Radius	90 .00		
35 .09 = Cor. lat.	To S. ſun's amplitude	26 .15	77 .23	

Sun's true amplitude N. 63 .45 Eaſterly
Sun's magnetical amplitude N. 77 .23 Eaſterly

Variation weſt 13 .38

The Geometrical Conſtruction. Pl. III, Fig, 93,

With the chord of 60 degrees, draw the circle N. E. S. W. being placed at the center, then ſet the magnetical amplitude 12 .37 from E. to F. and the true amplitude from E. to G, then the extent from E to N, laid the ſame way from G, gives falſe north, which angle 13 .30 is weſt variation, but if the amplitude had been taken at ſun ſetting and ſet from W, to E. and G. the extent E. N. laid from G. would give falſe N. to the eaſtward, and ſo would be 13 .30 eaſt variation.

Example 2d. January 4th. 1772. In latitude 52 .35 N. the ſun's magnetical being found W. 52 .17 ſoutherly at ſun ſetting, required the variation of the compaſs,

From	90 .00	*Then for the Sun's amplitude*	
Subtract	39 .30		
Co. latitude	37 .25	As S. C. lat. : ſun's dec. : : Rad. : S. ſun's amp.	
		37 .25 : 22 .45 : : 90 .00 . 39 .30	

From	90 .00		90 .00
Subſtract	39 .30		52 .17
True amp.	S. 50 .30 weſterly	Mag. amplitude	37 .43
Mag. amp.	S. 37 .43 weſterly		
Variation	12 .47 weſt.	As plainly appears by the rule given at ſetting.	

Example 3d. March 1ſt. 1772, In the latitude 56 .37 N. the Sun's magnetical amplitude being W. 5 .17 northerly at the ſun's ſetting, the variation of the compaſs is required.

From	90 .00	From	90 .00
Subtract	56 .37	Subtract	5 .17
S. Co. lat.	33 .23	Mag. amplitude	84 .43 from N.

As

As S. Co. Lat.	33 .23
Is to the S. sun's decli.	7 .16
So is Radius	90 .00
To S. sun's amplitude	13 .15
Added to 90 .00 gives sun's true amplitude N.	103 .15

Sun's true Ampli. N.	103 .15 W.
Sun's mag. ampli. N.	84 .43 W.
Variation West	18 .32

As was required.

Example 4. In latitnde 48 .38, on September 1st. 1772; The Sun's magnetical amplitude being E. 6 .07 southerly at the sun rising, the variation of the compass is required?

From	90 .00	To	90 .00
Substract	48 .38	Add	6 .07
	41 .22	M. Am,	96 ,07

Sun's mag. ampli.	N: 96 .07 E.
Sun's true amplitude	N. 77 .52 E.
Variation West	18 .15

As S. C. latitude	41 .22
Is to sun's declination	8 .03
So is Radius	90 .00
To S. sun's amplitude	12 ,08
Subtract from 90. 00	77 ,52

Example 5th. In the latitude 47 .31 south; on December 9th. 1772. The magnetical Amplitude being E 53 .28 southerly at sun rising; I demand the variation of the compass?

From	90 .00		90 .00
Substract	47 .31		53 .28
Comp. latitude	42 .29	Magnitical Amplitude	36 .32

As S. Co. latitude	42 .29
Is to S. S. declination	22 .56
So is Radius	90 .00
To S. sun's amplitude	35 12
Subtract from 90 .00 rem,	54 .48

True Amplitude	S. 54 .48E,
Magnitical amplitude	S. 36 ,32E.
Remains	18 .16

18 .16 The variation West.

Example 6th. June 15th, 1772. In the latitude 46 .17 S. the sun's compass amplitude being W. 50 .36 southerly at setting; required the variation of the compass?

From	90 .00	As S. Co. lat.	43 ,43	To	90 ,00
Substract	46 .17	Is to S. sun's decli.	23 .23	Add	50 ,36
Co. lat.	43 .43	So is Radius	90 ,00		
		To S. sun's amp.	35 .15	Ma, am.	140 ,36
		Add to 90, 00	125 15		

Sun's

Sun's magnetical Amplitude	S. 140 .36 Westerly.
Sun's true Amplitude,	S. 125 .15 Westerly.
Variation required	15 .21 West.

Example 7th. 1772. In the latitude 46 .44 S. the sun's compass amplitude being E. 22 ,51 southerly at sun setting? I demand the variation of the compass.

From	90 .00	From	90 .00	The sun's declination being 23 .04
Subtract	46 .44	Subtract	22 .51	
S. Co. lat.	43 .16	Mag. amplitude	67 .09	

As S. Co. Lat.	43 .16	Sun's mag. ampli.	67 .09
Is to the S. sun's decli.	23 .04	Sun's true Ampli.	54 .40
So is Radius	90 ,00		
To S. sun's amplitude	35 .20	Variation West	12 .14
Sub, from 90 .00 rem.	54 .40	As was required.	

Example 8th. September 11th. 1772. In the latitude 44 .31 S. found the sun's magnetical amplitude E. 5 .17 southerly at sun rising; required the variation of the compass?

From	90 .00	From	90 ,00	The Sun's declination being 4 .18 N.
Subtract	44 .31	Subtract	5 .17	
Co. latitude	45 .29	Mag. am.	84 .43	

As S. Co. latitude	45 .29	True Amplitude	S. 96 .03E.
Is to Sun's declination	4 .18	Sun's Mag. amp.	S. 84 ,43E.
So is Radius	90 .00		
To S. sun's amplitude	6 .03	Variation East,	11 .20
Add to 90 .00 makes	96 .03		

RULES for keeping a JOURNAL of a Voyage.

BY keeping a journal we mean keeping such an account of the ship's way, that at any time we may be able to know what latitude and longitude the ship is in.

When a ſhip is bound from one place to another, that ſhe is ſo far from it, that ſhe is obliged to go out of ſight of land for any conſiderable time, as ſuppoſe from England to Barbadoes, then at the time ſhe leaves the land ſhe is ſaid to take her departure, and that part of the land ſhe then leaves, as ſuppoſe the Start, the Lizard, the Lands End, &c. Is ſaid to be the place they took their departure from; and at the time of taking ſuch departure, the Captain or Mate, generally takes the bearing and diſtance of that land according to his judgment, and ſets it down in the logboard or in the log-book, againſt the time it was taken thus,

Lizard N. by W. diſtance five leagues or fifteen miles.
Or Start N. N. E. diſtance ſix leagues or eighteen miles.

And in the ſame manner for any other place, bearing, and diſtance, as you will ſee in the firſt day's log of the following journal.

The log book being mark'd as follows, with columns for courſe, diſtance, northing, and ſouthing, eaſting, and weſting; latitude by dead reckoning, latitude by obſervation, meridian diſtance, longitude made, and longitude in; you are to take notice, that in the column for courſe, you are always to ſet down the courſe you have made by your reckoning for that 24 hours (that is from the noon of the day before, to the noon of the day you work on) the ſea account being always kept from noon to noon.

In the column for diſtance you are to ſet down the diſtance made by your reckoning for 24 hours, marking the column with N. if the difference of latitude be northerly, or with S. if it be ſoutherly.

In the column of eaſting or weſting, you muſt likewiſe ſet down the departure made that 24 hours, marking the column with E. if the departure be eaſterly, or with W. if it be weſterly.

In the column marked Lat. by D. R. you muſt ſet down the latitude you are in by dead reckoning that day.

In the column marked lat. by obſervation, you muſt ſet down the latitude you find yourſelf to be in by obſervation if you have one, if not then let it ſtand open.

In the colum for mer. diſt. you are to ſet down in miles, how much departure you have made in all from the place you took your departure from.

In the column of longitude made, you are to ſet down (in degrees or miles) how much difference of longitude you have made in all from the place you took your departure from.

In

In the column of long. in, you are to ſet down what longitude you find yourſelf to be in, on that day by your reckoning.

Note, The account of longitude made, being what is always in his Majeſty's navy; and the account of longitude in, being moſt generally kept on board the merchant ſhip. I ſhall in this treatiſe ſhew how to keep them both, and ſhall leave it to the navigator's choice, which he will make uſe of, they both being equally true, and there being no occaſion to keep more than one of them.

And now having (I think) given a ſufficient account of the things that are to be ſet down in the ſeveral columns, I ſhall lay down theſe neceſſary rules following, and then proceed to ſhew how they are all to be found, or the method of working a day's work at ſea.

Rule 1ſt. Variation, if there be any (as moſt commonly there is) muſt be allowed upon all courſes ſteered, and upon all bearings &c. that are taken by the compaſs, that is, if it be eaſt variation, it muſt be allowed to the right hand; but if weſt variation, then allow it to the left hand of the courſe or bearing: ſuppoſing yourſelf placed in the center of the compaſs and looking directly forward to the point you are to allow the variation from.

Example. Suppoſe I ſteer S. W. and there is one point weſt variation, then my true courſe will be S. W. by S. or ſuppoſe I ſet a point of land, and find it to bear by my compaſs E. S. E. and I know there is half a point eaſt variation, then the true bearing is S. E. by E. half E.

Rule 2d. Leeway, which I ſhall not here deſcribe becauſe ſufficiently known to every ſea-man it muſt be allowed to the right hand of the courſe ſteered when the larbord tacks are aboard, and to the left hand when the ſtarbord tacks are aboard.

Example. Suppoſe I ſteer N. E. by E. with my larboard tacks aboard, and make one point leeway, then my courſe made good is E. N. E. but with ſtarboard tacks aboard N. E.

Rule 3d. Leeway and variation, when they are both to be allowed one way, that is both to the right hand, or both to the left, add them together, and allow this ſum the ſame way they are to be allowed. But if they are to be allowed one to the right hand, and the other to the left, ſubtract the leſſer from the greater, and allow the remainder the ſame way as the greater of them was to be allowed.

Example. Suppoſe I ſteer N. N. W. with my ſtarboard tack aboard, and make one point leeway, there being at the ſame time half a point weſt variation; I would know the true courſe?

Leeway to the left hand,	one point	
Variation to the left hand	half a point	Makes her true course
Their ſum to be allowed,	one point and a half	N. W. by N. half W.

Example 2d. Suppoſe I ſteer S. W. by W. with my larboard tacks aboard, and make two points and a half leeway, and I have half a point weſt variation; what is my true courſe?

Leeway to the right hand	2 points and a half
Variation to the left hand	1 point and a half
The remainder to be allowed to the right hand	1 point makes the courſe W. S. W.

Rule 4th. When a ſhip is lying too under a main ſail, mizon, &c: then obſere how ſhe comes up, and falls off, and take the middle between the two points, and from that allow the leeway and variation, as in rule third.

Example. Suppoſe a ſhip lying too under a main ſail, with her ſtarboard tack aboard, comes up E. by S. and falls off N. E. by E. their being one point weſt variation, and ſhe makes 5 points leeway, what courſe does ſhe make.

The middle between E. by S. and N. E. by E. is E. by N. from which allowing 6 points to the left hand, by rule 3d, the true courſe will be N. by E.

Rule 5th. Currents, the way they ſet you, and the diſtance you ſuppoſe you are driven by them, is to be ſet in the traverſe table for the day, as any other courſe or diſtance.

Example. Suppoſe I try the current, and find it to ſet W. by N. by the compaſs one mile an hour, the variation one point E, then if I ſail in that current twenty-four hours, I ſet down in the traverſe table as a courſe, W. N. W. diſtance 24 miles.

Rule 6th. Heave of the ſea is to be accounted for in the ſame manner as currents; As ſuppoſe there is a great ſea heaving towards the S. W. by my compaſs, there being half a point weſt variotion, I then ſet down in the traverſe table S. W. by S. half W. with ſo much diſtance I judge the ſea has heaved the ſhip.

Rule 7th. At leaving the land, the oppoſite point to the bearing with the variation, allowed upon it, and the diſtance you judge yourſelf from it, muſt be ſet down in the traverſe table as a courſe and diſtance.

Example.

Example. Suppoſe having one point and a half W. variation, the Sart bears by the compaſs N. N. E. diſtance 16 miles, the oppoſite point to N. N. E. is S. S. W. which with the variation allowed to the left hand, makes S. three quarters W. for the courſe to be ſet in the traverſe table, diſtance 16 miles.

Rule 8th. When you make the land the bearing itſelf (with the variation allowed upon it) and the diſtance you judge yourſelf from it, are to be ſet in the traverſe table as a courſe and diſtance. This needs no example.

Note. If you keep only the account of longitude made, and would at any time know, what longitude you are in, look out the longitude of the place you took your departure from, and with that longitude and the longitude made, taken as difference of longitude, find the longitude come to, by the rules for longitude before given, and the longitude ſo found muſt be counted from the ſame meridian that the tables you looked out the longitude of the place departed from counts it.

Rules to Correct the Dead Reckoning by an Obſervation.

WHEN you have made all the proper allowances you can, ſuch as variation, leeway, currents &c. and ſtill find that your latitude by dead reckoning will not agree with the latitude by obſervation within five minutes or miles, then you muſt correct as follows.

Caſe 1. *If your Courſe by Dead Reckoning be due North or due South.*

The Rule. Firſt find the difference of latitude (in miles) between the laſt obſervation and the obſervation on the day you correct, which will be the true difference of latitude. then will your courſe be the ſame as the courſe by dead reckoning, your true diſtance the ſame as the true difference of latitude; your departure (o), and your meridian diſtance longitnde made (or latitude come to) will be the ſame as they were on the day you had the laſt obſervation.

Caſe 2d. *If the Courſe found by Dead Reckning be leſs than three Points or* 33 .45.

The Rule. Firſt find the difference of latitude in miles, between the laſt obſervation, and the obſervation on the day you correct, which will be the difference of latitude, allowing your courſe the ſame as the courſe

courſe found by dead reckoning ſince the laſt obſervation, and with that courſe and the true difference of latitude, find the true diſtance and departure (as in the ſecond caſe of plain ſailing) then to find the meridian diſtance, difference of longitude, and longitude come to; take this Rule.

Note, but the difference of longitude is to be found by the true courſe, and the meridian difference of latitude between the obſervations (as uſual) and the meridian diſtance, longitude made, or longitude in, are to be found by adding or ſubtracting the true departure, and difference of longitude to or from the meridian diſtance, longitude made, or longitude in, on the day you had the laſt obſervation, which is the day you always correct from.

Caſe 3d. If the Courſe found by Dead Reckoning, be more than 3 points or 33 .45, *and leſs than 6 points or* 67 .30.

Rule. Firſt find the difference of latitude in miles between the laſt obſervation and the obſervation on the day you correct, which will be the true difference of latitude; then with the courſe found by dead reckoning ſince the laſt obſervation, and the true difference of latitude, find a new departure, (by the ſecond caſe in plain ſailing) add this new departure, to the departure found by dead reckoning ſince the laſt obſervation, and take half their ſum for the true departure; then you have given, the true difference of latitude and departure to find the true courſe and diſtance, [by the 6th. caſe in plain ſailing]

Caſe 4th. If the Courſe found by Dead Reckoning be more than ſix points or 67 .30.

The Rule. Firſt find the difference of latitude in miles between the laſt obſervation and the obſervation on the day you correct, which will be the true difference of latitude, and make your true departure the ſame, as the departure found by dead reckoning ſince the laſt obſervation; then you have given the true difference of latitude and departure, to find the true courſe and diſtance [by caſe 6th. of plain ſailing.

Note, As the knowledge of which caſe you are to correct by, depends upon knowing your courſe by dead reckoning and as when you correct only for one day, that courſe is always found by the difference of latitude and departure in your traverſe table for that day; therefore if you are to correct for a longer time than one day, you are to take the northing, ſouthing, eaſting, and weſting, that you have made for every day ſince the laſt obſervation, or if it be for your firſt obſervation, then for ever day from your leaving the land, minding not to leave out the difference of latitude and departure for the day you are correcting

correcting on, and bring them into a traverse table, by which you will find the whole difference of latitude and departure, made by dead reckoning since the last observation, and with that same difference of latitude and departure, find the course made by dead reckoning, then observe which of the foregoing cases that course comes under, and correct by the rules for that case, finding every thing except the distance. And when you have so corrected, you must only set down in your book the latitude by dead reckoning, the latitude by observation, the meridian distance and longitude made, or longitude in, and rub out the course, difference of latitude and departure.

Then you have given, the latitude by observation on the day you correct, and the latitude by dead reckoning on the day before it, to find the difference of latitude for the last twenty-four hours, by the rule for latitude before given. Also the meridian distance on the day you correct; and the meridian distance on the day before it, to find your departure by subtracting the less from the greater, if they be both east or both west, or by adding them together if one be east and the other west, and with that difference of latitude and departure, find your course and distance by the 6th case of plain sailing; which course, distance, difference of latitude and departure, are to be set down instead of those you rubbed out.

Rules to find the Meridian Distance.

Case 1st. If the meridian distance on the day you work from be east, and you have sailed to the eastward; or if it be west, and you have sailed to the westward, then add the departure to the meridian distance, you have made of the same name with that you worked it from.

Example 1st.	Meridian distance	W. 517 miles
	Departure westerly	121 miles
	Meridian distance in all	638 miles

Case 2d. If your meridian distance be east, and your departure be westerly; or if the meridian distance be west, and depature easterly, then subtract the less from the greater, the remainder will be the meridian distance you have made of the same name with the greater of the two.

Example 2d.	Meridian distance	797 miles W.
	Depature East	119 miles E.
	Meridian distance	187 miles E.
Example 3d.	Meridian distance	109 miles W.
	Distance Easterly.	296 miles E.
	Meridian Distance in all	187 miles E.

A

Journal of a Voyage,

FROM

ENGLAND,

TOWARDS THE

Iſland *MADERA.*

Taking our departure from the Start, in lat. 50 .07 N and longitude 3 .47 W. from London. Madera in latitude 32 ,44 N, and longitude 17 ,20 W.

Our courſe from Start point, S, 28 ,15 weſterly, or S. W. $\frac{1}{2}$ W, Diſtance 1259 miles, or 419 $\frac{2}{3}$ leagues
Difference meridians 596 miles or 198 $\frac{2}{3}$ leagues
Difference of latitude 1103 miles or 367 $\frac{2}{3}$ leagues
Difference of longitude 119 miles or 253 leagues.

H.	Courſes	knts.	h. k	F.	Winds	Le-way
2						
4						
6	The Start N. by E. diſt. 18 miles					
8	S. W. by W.	4			N. E.	
10		4	1			
12		5				
2		5				
4	S. W.	5	1			
6		5	1			
8		5	1			
10		5	1			
12		6				

TRANSACTIONS:

Tueſday Aug. 25, 1772.

Moderate Gales and fair weather at 6, (P. M) the Start bore per. log. from which we took our departure, it being in latitude 50 .07 N. and longitude 3 .47 W.

Variation one point and a quarter Weſt.

	Courſe cor.	diſt.	N	S.	E.	W	M. D	lat. Ob.	lat. d. r	× lon.	long. in
	S. 30. 00 W.	108		98		53	53		8 .34	2 W.	5 .09

The manner of working this Day's Work

The oppoſite point to the bearing of the land is S. by W. which with the variation allowed upon it, (as before taught) makes S 1 q. E. and the diſtance from the land 18 miles, which are to be ſet down for the firſt courſe and diſtance in the following traverſe table.

Then the firſt courſe ſteered being S. W. by W the variation allowed upon it, makes it S. w. by S. three quarters W. and the ſum of all the diſtances from 8 o'clock, where that courſe begins, to two o'clock where it ends, being 18 miles and a half, we double their ſum, becauſe the book is marked only for every two hours, and it makes 37 miles for the diſtance; belonging to that courſe.

But if the book had been marked for every hour as it is in the Royal Navy and aboard Eaſt India ſhips, then we muſt have taken the ſum without doubling it for the diſtance, and in the ſame manner we reckon the other courſe and diſtance, all which appears in the traverſe table following, and then every thing required we ſet down in their proper columns,

The Traverse Table.

Numb.	Courses	dist.	N.	S.	E.	W.
1	S. $\frac{1}{4}$ E.	18		18	0.9	
2	S. W. by S. $\frac{1}{4}$ W.	37		27.4		24.8
3	S. S. W. $\frac{1}{4}$ W.	56		48.		28.8
	Difference of latitude South			95.4	0.9	53.6
						0.9
	Departure West					52.7

The several courses and distances in this table being looked out and cast up as in the rules for traverse sailing beforegoing, I find my difference of latitude to be 93.4 miles, and my departure 52.7 miles; I then mark down on my slate or paper that I work upon, every thing that is to be found, and as I find what they come to, I set against them as follows.

Dead Rec.

Course [illegible] W.
Distance [illegible] miles.
Difference of lat. 93 S.
Departure 53 W.
Lat. by D. R. 48 .34 N.
Lat. Observation
Merid. distance 53 miles
Lon. made or × lon. 82 m.
Long. come to 5 .49 W.

Because the difference of latitude is S. and the departure W. they must stand in S. and W. col. Note, when the tenths in any side are more than five or half miles, you may call that side one mile more then you found it to be, but where they are less than 5, then you need take no more notice of them.

As in this case the difference of latitude being 93.4 we reject the 4 and call it only 93 miles; and the departure being 52.7, instead of the 7 you may put one mile to it and call it 53; but when you take the difference of latitude and departure to find the course by them, then take them in miles and tenths; in the first place with my difference of latitude and departure 52.7 (by the 6th case of plain sailing) we find the course to be 30 degrees, and distance 108 miles, which I set down against course and distance as before.

Second for the latitude by D. R.

Take the lat. sailed from	50 07
Subtract the dif. of lat.	1 33
Remain. the lat. D. R. N.	48 34

Third, for the M. D.

Note, the meridional distance on the first days work is always the same as that days departure.

Then

Then find the course in the tabe of × of latitude and departure, and the meridian difference of latitude in the column belonging to that course, the departure 82, which answers to the difference of latitude, is my difference of longitude.

For the Longitude come to.			*For the × of Longitude.*		
Longitude Start		3 .47 W.	Lat. dep,	50 ,07	M, P, 3485
× of Long.	82 m,	1 .22 W.	Lat, D, R,	48 ,34	M, P, 3343
Longitude come to		5 .09 W.	Mer, × of latitude		142

Note, this method to find the difference of longitude by traverse tables is used in the Royal Navy.

H.	Courses	knts	h.kt.	Winds.	Lee way.
2	S.w.byw.	6		North.	
4		5	1		
6		5		N. W.	
8		5			
10	S. W.	4	1	South.	
12		4	1		
2		4	1		
4		4	1		
6		4	1		
8	S.W.byS.	5		W.N.W.	
10		4	1		
2		4			

TRANSACTIONS.

Wednesday Aug. 26, 1772.

Moderate gales and fair weather, at five (A. M.) saw a ship to the northward.

Variation one point and a quarter west.

Courses corect.	dist.	N.	S.	E.	W	× long	M.D	lat. Ob.	lat. d. r.	long. in
S. 33 .co W.	114		96		61	93	114		46 .58	6.42

The variation allowed for, and the distances summed up as appears in the annexed traverse table.

Numb.	Courses.	dist.	N.	S.	E.	W.
1	S. W. by S. ½ W.	43		31.9		28.9
2	S. S. W. ½ W.	45		38.6		23.9
3	S. by W. ½ W.	27		25.4		9.1
	Difference of Latitude	95.9	dist.			61.1

The course and distance found by Case 6th, of Plain sailing, will be as in the other columns.

By Dead Rec.	Course	S. 32 .28 W.	
	Distance	114 miles.	
	Difference of lat.	96 S.	
	Departure	61 W.	
	Lat. by D. R.	46 .58 N.	
	Lat. by Obs.		
	Mer. distance	114 W.	
	× of long.	93 W.	
	Longitude in	6.42 W.	

For our Latitude by Dead reckoning.

Latitude D. R. yesterday	48 .34N.
× lat. to day 90 m. =	1 .36N.
Lat. D. R, this day	46 .58N.

To find the Meridian Distance.

Merid. dist. yesterday	53 W.
Dep. or × mer. to day	61 W.
Mer. dist. to day	114m.

With the course and meridian × of latitude as before in the last days work, we find by the traverse table, by taking the course 33 deg. we find the difference of longitude = 93 miles west.

For the Difference of Longitude.

Lat. yesterday 48 .34 M. P.	33,43
Lat. this day 46 ,53 M. P.	32.00
Meridian × of lat.	143

For the Longitude ship is in.

Longitude yesterday	5. 09
× of long. to day	1 ,33
Long. ship is in	6 ,42

Note, it is usual in the Rayal Navy and East India ships, to keep an account of longitude made, that is, the × of longitude in degrees and minutes carried on like as we do the meridian distance, viz. 82 + 93 = 175 and ÷ 60 = 2,55,

H.	Courses	knts	kt.	Winds.	Leeway
2	S. W.	4		W. N. W	
4		4			
6		4			
8	S. w. by S	4	1	W. by N.	½
10		4	1		
12		4	1		
2	S. S. W.	4	1	West.	1
4		4			1
6		4			
8		4			
10		4			
12		4			

TRANSACTIONS,

Thursday Aug. 27, 1772

Moderate gales and cloudy, at 12 reeft our topsails.

The Leeway and variation allowed as before taught, the traverse table is as follows.

Courses corect.	dist.	N.	S.	E.	W	× long	M.D	lat. Ob.	lat.d. r.	lo. is
S. 14 .15 W.	97		94		24	34	138		45 .23	7. 16

The

Numb.	Courſes	diſt.	N.	S.	E.	W.
1	S. W. by S.	24		20.		13.3
2	S. by W. $\frac{1}{2}$ W.	36		34.5		10.4
3	South	40		40.		

By dead Rec.

Courſe	S, 14 .15 W.
Diſtance	97 miles
Difference of lat.	95 S.
Departure	24 W.
Lat. by D. R.	45 .23 N.
Lat. Obſervation	
Mer. diſtance	138 W.
Long. made	3. 29 W.
Long ſhip is in	7. 16 W.

Latitude yeſterday	46 .58 N.
× of lat. to day	1 .36 S.
Gives lat. D. R.	45 .22
Meridian diſt. yeſt.	114
Departure to day	24
Meridian diſt. to day	138

Courſe and diſtance is found by the 6th Caſe of plain ſailling as before, and will be as in the other columns.

To find the × of lon. by the table

Lat. 16 .58	M, P,	3200
Lat. 45 ,22	M, P,	3063
M. difference of lat,		137

With the courſe 14 .15 and meridian difference of latitude 137, the difference of longitude is found = 34

H.	Courſes	knts.	h, kt. F.	Winds,	Lee-way,
2	South	4		W, S, W,	1
4		4			
6		4	1		
8		4			
10	S. S, E.	4		S, W,	1 $\frac{1}{2}$
12		4			
2		4			
4		4			
6		4			
8	S, by E.	4		S,w,byw,	2
10		4			
12		3	1	Tacked	

TRANSACTIONS,

Friday Aug, 28th, 1772.

Moderate Gales and hazy at 8 A, M, reeſt both top-ſails for the firſt part; the latter, freſh gales and rain, at 4 P, M, handed both top ſails,

Variation 1 point W,

Courſes corect,	diſt,	N,	S,	E,	W	× long	M, D lat, Ob,	lat, d, r,	long, in
S, 39 .45 E,	94		72	69		85	78	44 ,11	5 ,51 W,

The

The ſhip having her ſtarboard tacks aboard when the leeway and variation are allowed (as before taught) the traverſe table will ſtand as follows.

The Traverſe Table.

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	S. S. E.	33	2		30.5	12.6	
2.	S. E. $\frac{1}{5}$ E.	40	$4\frac{1}{5}$		25.4	30.9	
3	S. E.	12			16.3	16.3	
				Difference of Lat, 72	dep,	60	

Having been very particular in explaining the manner of working a days work, in the foregoing days, and as all days works where there is no correction wanting, are to be worked from the × of lat. and dep. found from traverſe table, as before; I have here only ſet down the traverſe table and the other requiſites,

By dead rec,

Courſe	S, 39 45 E,
Diſtance	94 miles
× of latitude	72 S,
Departure	60 E.
Latitude D, R,	44,11 N,
Latitude Ob.	
Mer, diſtance	78 mi, w,
× of longitude	85 w,
Long, come to	5 ,51 w.

H.	Courſes	knts,	h.	kt.	F,	Winds,	Lee-way.
2	N.w.byw.	4				S,W,byS,	2
4		3					
6		3					
8		3					
10		3					
12	N. W.	3		1		W, S, W,	3
2		3		1			
4		3		1			
6		3					
8	N,w,by N.	3				W. by S,	$3\frac{1}{2}$
10		3					
12		3					

TRANSACTIONS.

Saturday Aug. 29, 1772,

Freſh gales and rain all theſe Twenty-four hours; at 10 handed top ſails.

Variation 1 point W.

Courſes corect,	diſt.	′ N,	S.	E	W	× long	M,D	lat,Ob,	lat,d, r,	long, in
N, 29 ,15 W.	74	65			36	51 W.	114		45 ,16	6 42 w,

The

The ſhip having her ſtarboard tacks aboard, when the leeway and variation allowed, the traverſe table ſtands thus.

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	N. W.	22	4	22.6			22.6
2	N. N. W.	33	2	30.5			12.6
3	N. ½ W.	12	½	11.9			1.2
Difference of Latitude				65.w	depat.		36.4

To find the courſe.

Note, in this caſe the × of lat. being juſt 65 without any tenths, after you have put two cyphers to the departure, you muſt not divide it by 65 but by 650, the figures being put to ſupply the place of tents as divided in the rule for plain ſailing thus 650) 36,400 (56. = the natural tangent courſe, anſwering to 29.15

By dead rec.

Courſe	N, 29,15 w.
Diſtance	74 miles
× of lat,	65 N,
Departure	36 w,
lat, by D, R.	45,16 N,
Latitude Ob,	
Mer, diſtance	114 w,
× of longitude	51 m,
Long, come to	6,42 w,

H.	Courſes	knts	h, kt		Winds	Lee-way,
2	w, N, w,	3			S, W.	3½
4		3				
6		3				
8	Lay too					
10	N, N, w,				South	5
12						
2						
4	N, by E,				S, W, by S,	
6						
8						
10	North				W, S, W,	
12						

TRANSACTIONS *Sunday Aug.* 30th, 1772.

Handed the foretop-ſails at 8, the ſhip lay too up N, w, off N, the middle is N, N, w, as per log.

At 4, (P, M,) up N, by w, off N, E, by N, the middle is N. by E,

At 10, (P, M,) up N, N, w, off N, N, E, the middle is North.

Variation 1 point weſt.

Courſes corect,	diſt,	N,	S,	E	W × long	M, D	lat. Ob,	lat, d, r,	long, in
N. 5, 09 E.	35	34			7	104		45,58 N	6,35 w

Having

Having allowed the lee-way and variation upon the firſt courſes, and alſo from the middle between what ſhe comes up and falls off, as before ſhewn, the traverſe table is as followeth.

Numb.	Courſes	diſt,	P.	N,	S,	E.	W.
1	N.W.b,N.½W.	18	3½	13,9			11,4
2	N. N. E.	12	2	11,1		4,6	
3	N. E.	9	5	5,0		7,5	
4	N, E, by E,	6	4	4,2		4,2	
	Difference of latitude		34	34,2		16,3	11,4
						11,4	
				Departure 5		4,9	

To find the Courſe,
× lat, : T, Rad, : : Dep, : T, C,
B, 34 : T, 45,00 : : 5 : T. 8,09

To find the Diſtance
S, C, : Dep, : : Rad, : Diſt,
S, 8,09 : 5 : : 90 ,00 : 35 m,

To find the difference of Long,
S, C, M, L, : dep, : : R. : × long
44 ,23 : 5 : : 90, : 7

By dead rec,

Courſe N. 8, 09 E,
Diſtance 35 miles
× of lat, 34 miles
Departure 5 miles
Lat, D, R, 45 ,58 N,
Lat, Ob,
Mer, diſtance 109 miles
× of longitude 7 E.
Long, in 6 ,35 W.

TRANSCTIONS:

H.	Courſes	knts.	h.kt.	F,	Winds.	Lee-way
2	N. w.	3			w, S, w,	4
4		3				
6	w. N. w.	3			S. w.	4
8		3				
10	N. W.	3	1		w. S. w.	3
12		3	1			
2		3	1			
4	w. by S.	4			S. by w.	2
6		4				
8		4				
10		4				
12	West	4	1		S. S. w.	1½

Monday Aug. 31ſt, 1772.

Freſh gales the firſt part, at 8 A, M. ſet main top-ſail

The the latter part moderate with ſmall ſhowers at 2 P, M, ſet foretopſail.

Variation one point.

Courſes	diſt,	N,	S,	E,	w,	× long	M,D	ar, Ob,	lat,d, r.	long in
S. 54 ,00 w.	73	42			58	83	167		46 ,4	7, 58 w

The

Numb.	Courſes	diſt,	P.	N,	S,	E.	W,
1	N, by W.	12	1	11,8			2,3
2	N. W. by N.	12	3	10,			6,7
3	N. N. W,	21	2	19,4			8,
4	Weſt	32	8				32,0
5	W, by N, ½ W,	9	7½	09,			9,
			Difference of Lat,	42	dep,		58

To find the courſe.

42,1)55,000(1,377 = the natural tangent 54,00

To find the Diſtance

54,00 : 58 : : 90 : 73 miles, the diſtance.

To find the difference of Long,

By Mid. lat, it is found = 83m,

Latitude yeſterday	45,58 N.
Difference of Lat. this day	42
Latitude D. R.	46,40 N.
Longitude yeſterday	6,35 w.
× of long. to day	1,23 w.
Long. ſhip is in	7,58 w.

For the meridional diſtance

Merid. diſt, yeſterday	109
Departure yeſterday	58
Meridian this day	167

H.	Courſes	knts.	h.kt.	F,	Winds	Lee-way
2	w. by N.	4	1		S. w. by S.	1
4		4	1			
6		4				
8	Weſt	4	1		S. S. w,	½
10		4	1			
12		4	1			
2	w. by S.	4			S. by w.	½
4		4				
6		4				
8		4				
10	W. S. w.	3	1		South	½
12		3				

TRANSACTIONS:

Tueſday Sept. 1ſt, 1772.

At 6, A. M. Reeft both top-ſails; moderate gales and thick hazy weather.

Variation one point w.

Courſes	diſt,	N,	S,	E, w, × long	M, D	lat, Ob,	lat, d, r.	ong in
S. 82,13 w.	96		13	95, 138	26		46,27	10,16

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	W. by N.	26	7	5,1			25.5
2	w. by S. ½ w.	27	7½		2,6		26.9
3	w. S. w. ½ w.	32	6½		9,3		30.6
4	S.w. b w ½ w,	13	5½		6,1		11.5
Difference of latitude		13,			18,0		94,5
Departure		95			5,1		
					12,9		

By dead rec,
Courſe S. 82, 13 w,
Diſtance 96 miles
× of lat. 13 miles
Departure 95 miles
Lat, D, R, 46,27 N,
Lat, Ob,
Mer. diſtance 262 miles w,
× of longitude 138 w.
Long, in 10,16 W.

To find the Courſe,

12,9) 94,5000(7.329 = N. T.
82,13 or S, 82,13 weſterly,

For the diſtance,

82,13: 95 : : 90,00 : 96 miles the diſtance. × of long. found by mercator is 138 miles.

Latitude yeſterday	46.41 N.
× of lat. to day	13
Gives lat. D. R.	46.27 N.
Meridian diſt. yeſt.	167 w.
Departure to day	95 w.
Meridian diſt. to day	262 m.
Longitude yeſt.	7.58 W.
× of Long.	2.18 W.
Longitude come to	10.16 W.

H. Courſes	knts,	h.	kt.	F,	Winds,	Lee-way.
2 w, S, w.	2	1			South	
4	2	1				
6	2	1				
8	2					
10	2					
12	2					
2	1	1				
4 S. w. by w.	1	1			S, by E,	
6	1	1				
8	1					
10		1				
12		1				

TRANSACTIONS.

Wedneſday Sep. 2 1772,

Little wind and ſmall ſhowers of rain.

A great ſwell from the S, W. from which I allow 6 miles.

Variation 1 point W.

Courſes coreſt.	diſt.	N,	S.	E,	W	× long	M, D	lat, Ob,	lat, d, r,	long, in
S, 56 ,46 W.	35		19		29	44	291		46 ,08	11 ,02

Numb.

Numb.	Courses	dist.	P.	N.	S.	E.	W.
1	S. W. by W.	30	5		16.7		24.9
2	S. W.	10	4		7.1		7.1
3	N. E. by N.	6	3	5		3.3	
	Difference of latitude	19			23.8	3.3	32.
	Departure	29			5		3.3
					18.8		28.7

By dead rec,

Course S, 56 46 w,
Distance 35 miles
× of latitude 19 m, S,
Departure 29 m, w.
Lat, D, R, 46 ,08 N,
Latitude Ob.
Mer, distance 29 miles,
× of longitude 44 m,
Long, come to 11 ,02 w.

For the Course
18,8) 28,7309 (1,526 Then
1,526 = N. Tang, 56 ,46 or
S, 56 ,46 W, and dist, = 35 m,
and all the rest as per column.
Latitude yesterday 46 ,27 N,
Difference of lat, 19 S,
Lat, D, R, 46 ,08 N,

Note, In this day's work the swell coming from the S. W, heaves the ship towards the N, E. and the variation allowed upon it, makes N, E, by N, for the last course in the traverse table.

H.	Courses	knts	h. kt.		Winds.	Lee way.
2	Calm		1			
4			1			
6			1			
8			1			
10			1			
12			1			
2			1			
4			1			
6			1			
8	S. S. W.		1		West.	
10			1			
12			1			

TRANSACTIONS.

Thursday Sept. 3d, 1772.

Tryed the curent and found it to set W. S, W, one mile an hour, at which rate I allowed it for this 24 hours.

Zenith dist, 52 ,49 S.
Declination 7 ,19
Lat, by Obs. 45 ,30

Variation one point W.

Courses corect.	dist.	N.	S.	E.	W	× long	M.D	lat. Ob.	lat. d. r.	long. in
S. 42 .31 W.	33		24		22	32	313	45 ,30	45 .33	1,3 W

Numb.	Courſes.	diſt.	P.	N.	S.	E.	W.
1	S. by W.	11	1		10.8		2.1
2	S. W. by S.	24	5		13.3		20.0
	Difference of Latitude	24			24.1	diſt.	22.1
	Departure	22					

By dead Reck.

Courſe	S, 42 .31 W.
Diſtance	33 miles
Difference of lat.	24 S.
Departure	22 W.
Lat. by D. R.	45 .33 S.
Lat. Obſervation	45 .30 S.
Mer. diſtance	313 W.
Long. made	32 W.
Long ſhip is in	11. 34 W.

For the Courſe
24 : 22 : : T. 45 ,00 : T, 42 ,31
the courſe S, 42 ,31 weſterly,

S, 42.31 : 22 : : R, 90 ,00 : 33 diſt.

S, C, M, L. : dep, : : R, : × lon,
viz, 43 ,41 : 22 : : 90 .00 : 32 = difference of longitude.

Note the current ſetting W, S, W. one mile per hour, I allow the variation upon it which makes it S, W, by w. and ſet it in the traverſe table as before,

H.	Courſes	knts.	h.	kt.	F,	Winds,	Lee-way,
2	S, by w.	3				W, by, N,	
4		3	1				
6		4					
8		4					
10		4					
12		4					
2		4					
4		4					
6		4					
8		4					
10		4					
12		4					

TRANSACTIONS,

Friday Sept, 4th, 1772,

Moderate Gales and fair weather, at A, M, ſpoke a ſhip from Barbadoes, and bound for London,

Variation 1 point W,

Courſes corect,	diſt,	N,	S,	E,	W	× long	M, D lat, Ob,	lat, d, z,	long, in
South	93		53				31 343 .47	43 ,57	11 ,37

Numb,

By Dead Rec.

Course	South
Distance	93 miles.
Difference of lat.	93
Departure	00
Lat. by D. R.	43 ·57 N.
Lat. by Obs.	43 ·47 N.

Corrected

Distance	103
× of latitude	103
Departure	00
Latitude by dead R.	43 ·57
Latitude Observation	43 ·57
Mer. distance	313 W.
Longitude made	747
Longitude ship	11 ·37

In this day's work there being ten miles difference between the latitude by dead reckoning, and observation, I am to correct it, and therefore I do not find the meridian distance &c. by dead reckoning as I did when there was no correction, but I mark them all down again as above, and correcting (as in case first of the rules for correcting) because my course by dead reckoning since the last observation was due South, I set them all down as in the above correction.

TRANSACTIONS,

Saturday Sept. 5th, 1772.

Moderate gales and clear weather.

Variation one point W.

H.	Courses	knts.	..kt.	Winds.	Lee-way.
2	S.w, by S.	4		W.N.W.	
4		4	1		
6		4	1		
8		4	1		
10		4			
12		4			
2		4			
4	S. S. W.	4	1		
6		4			
8		4			
10					
12					

Courses corect.	dist.	N.	S.	E.	W	× long	M.D	lat. Ob.	lat.d. r.	lo. in
S. 17 ·54 W.	112		97		31	48	408	42 ·01	42 ·10	12.25

Numb.

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	S. S. W.	60	2		55.4		23.0
2	S. by W.	42	1		41.2		8.2
× or Lat. 97 Dep. 31					96.6		31.2

Courſe found S. 17 .54 W, Diſtance by dead reckoning = 102.1

Dead Rec.
- Courſe S. 17 .54 W.
- Diſtance 102 miles.
- Difference of lat. 97 S.
- Departure 31 W.
- Lat. by D. R. 42 .10 N.
- Lat. Obſervation 42 .01 N

Latitude obſer, yeſterday 43 .47
Latitude obſer, to day 42 .01
Her × lat. 106 — 1 .46

S, C, C, : × lat, :: R. : diſt.
72,06 : 10,6 : : 90,00 : 112

Corrected
- Courſe S. 17 .54 W.
- Diſtance 112 miles
- Difference of lat. 106 miles
- Departure 35 miles
- Latitude D. R. 42 ,10 N.
- Lat. Obſeration 42 ,01 N,
- Merid. diſtance 348 miles
- Longitude made 8 ,35 W.
- Long. come to 12 .25 W.

90,00 : 112 : : 17,54 : 35
S, C, M, : lat, ob, : : dep, : Rad.
to × of long. That is
47,06 : 35 : : 90,00 : 48 = the true × of longitude.

N.	Courſes	knts.	h.	k.	F.	Winds.	Leeway
2	S. W.	4				N. W.	
4		4					
6		4	1				
8		4					
10	S.w.by w.	3					
12		4					
2		4	1				
4		3	1			North	
6		3	1				
8		3	1				
10		3	1				
12		3	1			N, E.	

TRANSACTIONS.

Sunday Sept. 6, 1772.

Moderate Gales and fine clear weather.

Variation 3 quarters of a point Weſt.

Courſe cor.	diſt.	D.	L.	M.	D.	M.	D.	M.	D.	M.	D.	M.
S. 47,07 W,	78		55		3	40	9. 5		.1 .06		10 .48		3 .41	

Numb

Numb.	Courses	dist.	P.	N.	S.	E.	W.
1	S.w.by S.$\frac{1}{4}$w.	33	$3\frac{3}{4}$		26.5		13.7
2	S. W. $\frac{1}{4}$ W.	58	$4\frac{1}{4}$		38.9		49.0
Difference of Lat. 65 Dep. 63					65.4		62.7

65.4)62.7000(.95 .87 = N. T.
or 43 .47 westerly,

When by D, R. distance 91 miles
× of latitude 65 S,
Departure 63 w,
lat. by D, R. 40,56 N,
Latitude Ob, 41,08 N,

S, C. C, : × lat, : : R. : dist.
46 .13 : 53 : : 90.00 : 74

Radius : dist. : : S. C. : × M.
90.00 : 74 : : 43 .47 : 51

In this case the course by D. R. since last observation being more than 33 and less than 67 degrees, it is corrected by case 3d.

Departure by D. R.	63
New departure	51
Sum	114
True departure	57

Now by the true dep. and true × of lat. 53 we get the following.

Course	S. 47 .07 W.
Distance	78 miles
× of longitude	53 miles,
Departure	57 W.
Latitude D. R.	40,56
Latitude observation	41 .08 W.
Mer. distance	45 w,
Longitude made	9.51 w.
Long. come to	13,41 w,

m.	Courses	knts	1, kt.	Winds	Lee way.
2	West,	4		S. E.	
4		4			
6		4	1		
8		4			
10		4		East,	
12		4			
2		4	1		
4		4	1		
6		4	1		
8		4	1		
10		4	1		
12		4	1	N. N. E.	

TRANSACTIONS

Monday Sept, 7th, 1772.

Cloudy the first part, the latter moderate and fair,

Variation half a point w.

Courses corect.	dist,	N,	S,	E.	W.	× long	M, D	lat. Ob,	lat. d, r.	long. in
West.	99				99	134	405	41 .08	40 .58	15 ,53

Numb.

Numb.	Courſe	diſt.	P,	N,	S,	E,	W,
1	w. by S. ½ w.	99	7½		9,7		98,5

Dead Reckoning

Courſe W. by S. half W.

Diſtance	99 miles
Difference of latitude	10 S.
Departure	98,5 W.
Latitude D, R.	40 58 N,
Latitude Obſervation	41 .08 N.

Corrected by caſe 4th the D, R, being more than ſix points.

Corrected.

Courſe	S, W.
Diſtance	99 miles
difference of latitude	00
Departure	99 miles
Latitude dead R,	40 .58
Latitude obſervation	41 ,08 N.
Merid diſtance	504
Longitude made	12 ,03
Longitude in	15 .53

Note, when the courſe is due eaſt or due weſt, as in this caſe, when the difference of latitude cannot be found by the courſe and merid. difference of latitude as before, but muſt be found as follows; look in the table of difference of latitude and departure for the neareſt degrees to your latitude, which here is 41; and in the difference of latitude column, belonging to that degree, find your departure which is 99, the diſtance, anſwering to which is 132, gives × of longitude.

H.	Courſes	knts,	h, kt.	Winds,	Lee-way,
2	S, by W,	4	1	North,	
4		3	1		
6		3			
8		3			
10	S, S, w,	3		N, W.	
12		3			
2		3			
4		3			
6	S, b, w ¼ w,	3		W. N, w,	
8		3			
10		3			
12					

TRANSACTIONS,

Tueſday Sept, 8th, 1772,

Little wind and hazy, all theſe 24 hours.

Variation half a point w,

Courſes corect,	diſt,	N,	S:	E,	w.	× long	M, D	lat, Ob,	lat, d, r,	long, in
S, 11 ,03 w	76		74		14	19	518		39 ,54	16 .12

Numb.

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	S. ½ W.	28	½		27.9		2.7
2	S. b. W. ½ W.	24	1½		23.		7.
3	S. by W.	24	1		23.5		4.7
Difference of Lat. 74 Dep. 14					74.4		14.4

By dead Rec.

Courſe S, 11 .03 W.
Diſtance 76 miles
Difference of lat. 74 S.
Departure 14 W.
Lat. by D. R. 93 .54 S.
Lat. Obſervation
Mer. diſtance 515 W.
Long. made 12 .22
Long ſhip is in 16. 12 W.

74.4)14.4000(.1935 = N. T.
11 .03 the courſe.
S.11.03 : 14,4 : : S. 90,00 : 79 diſt.

Lat: Ob. yeſterday	41 .08 N.
× of lat. to day	1 .14 S.
Gives lat. D. R.	39 .54 N.

S.C.M. : × mer. : : R. : × long.
S. 49 .29 : 14 : : 90 .00 : 19

Longitude yeſt.	15 .53
× of Long.	19
Longitude come to	16 .12

Having in the foregoing days works given an example to every caſe of correcting for a ſingle day, we ſhall now ſet down three day's work by dead reckoning, and ſhew how to correct them all together by an Obſervation.

H.	Courſes	knts,	h, kt,	Winds,	Lee-way,
2	S, S, w,	3	1	W. by N.	
4		3	1		
6		4			
8		4			
10	S, by W,	4		West.	
12		3	1		
2		3	1		
4	South	3	1	W. S, w,	
6		3			
8		3			
10	S, b, w ¼ w,	3.		West.	
12		2			

TRANSACTIONS,

Wedneſday Sept, 9th, 1772.

Little wind and cloudy.

Variation 3 quarters of a point Weſt.

Courſes corect.	diſt,	N,	S:	E,	w.	× long	M, D	lat, Ob,	lat, d, r,	long, in
S, 4 ,56 w.	82		82		8	10	526		38 ,32	16 .22

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	S. by W. $\frac{1}{4}$ W.	30	$1\frac{1}{4}$		29.1		7.3
2	S. $\frac{1}{4}$ W.	22	$\frac{1}{4}$		22.		1.1
3	S. $\frac{3}{4}$ E.	19	$\frac{3}{4}$		18.3	2.8	
4	S. $\frac{3}{4}$ W.	13	$\frac{3}{4}$		11.9		1.9
Difference of latitude		82,			81.3	2.8	10.3
Departure		8					2.8
							7.5

By dead reck,
- Courſe S. 5, 07 w,
- Diſtance 82 miles
- × of lat. 82 miles
- Departure 8 miles W.
- Lat, D, R, 38 ,32 N,
- Lat, Ob,
- Mer, diſtance 526 miles w.
- long. made 12.32 w.
- Long, in 16 ,22 W,

Courſe found thus, As × of lat, : T. Rad. : : dep. : T. courſe = 5.07, and diſt. = 82 miles.

Latitude yeſterday 39 ,54 N,
Difference of lat, 1 .22 S,

Lat, D, R, 38 ,32 N,

To find the difference of long.

As S. C. Mid. lat. 50 .46 is to dep. 8 ſo is Rad. 90 .00 to the × long. = 10 miles weſt.

H.	Courſes	knts,	h, kt.	F,	Winds,	Lee-way.
2	S. bw. $\frac{3}{4}$ w.	3	1		W. by N.	
4		3	1			
6		3	1			
8		3				
10		3	1			
12		3				
2		3				
4	S, by w.	3			Weſt.	
6		3				
8		3				
10		3				
12		3				

TRANSACTIONS.

Thurſday Sept. 10, 1772.

Little wind and fair weather.

Variation 1 quarter of a point W.

Courſes corect,	diſt.	N,	S.	E,	W.	× long	M, D	lat, Ob,	lat, d, r,	long, in
S, 13 ,30 W.	77		74		18	23	544		37 ,18	16 ,45

Numb.

Numb.	Courſes.	diſt.	P.	N.	S.	E.	W.
1	S. by w. $\frac{1}{2}$ w.	46	$\frac{1}{2}$		4.4		13.3
2	S. $\frac{3}{4}$ W.	30	$\frac{3}{4}$		29.7		4.4
Diff of Lat.	74	Depart. 18			73.7	diff.	17.7

73.7)17,7000(.2401 = the Nat. T. 13 ,30 the courſe. S. Weſterly.
As S. C. 13 ,30 : Dep. 18 : : Rad. 90 ,00 : diſtance 77 miles. M.D.

By dead rec,

Courſe	S, 13 30 w,
Diſtance	77 miles
× of latitude	74 m, S,
Departure	18 m, w.
Lat, D, R,	37 ,18 N,
Latitude Ob.	
Mer, diſtance	544 miles,
long. made	12 ,52
Long, come to	16 ,45 w.

Lat. D. R. yeſt.	38 .32 N.	526
× Lat. to day	1 .14 S.	18
Lat. by D. R.	37 .18 N.	544

As S. C. m. lat. : Dep. 18 : : Rad. 90 .00 : × of long. 23

Long. yeſt.	16 .22	L m. 12.32
× Long.	23	× long. 23
Long. in	16 .45	lon.m.12.55

n.	Courſes	knts,	h, kt,	P,	Winds	Lee-way,
2	S. by W.	4			W. by N.	
4		4				
6		4				
8		4				
10		4				
12		4				
2	S. bw. $\frac{1}{4}$ w.	4				
4		4				
6		4				
8		4				
10		4				
12		4				

TRANSACTIONS

Friday Sept, 11, 1772.

Moderate Gales and fair

Variation one quarter of a point W.

Courſes corect,	diſt,	N,	S,	E,	W	× long	M,D	lat.Ob,	lat,d, r,	long, in
S. 9 ,50 w.	96		95		16	14		35 .31	35 .43	17 ,17

The Traverse Table.

Numb.	Courſes	diſt.	P.	N.	S.	E.	W.
1	S. ¾ W.	48	¾		47.5		7.4
2	S. by W.	48	1		49.1		9.4
× or Lat. 95 Dep. 16					94.6		16.4

Dead Rec.
- Courſe S, 9.50 W.
- Diſtance 96 miles.
- Difference of lat. 95 S.
- Departure 16 W.
- Lat. by D. R. 35.43 N.
- Lat. Obſervation 35.41 N

For the Courſe.
94.6)16.40000(.1733 = N. T, of 9.50 the courſe.

For the Diſtance.
As S. C. 9.50 : dep. 16 : : Rad. 90.00 : 96 the diſtance.

Now being to correct from the laſt obſervation, which was on Monday September 7th, we take the northing, ſouthing, eaſting, and weſting for every day ſince, and bring them into a traverſe table, as follows.

By the Dead Reckoning ſince the laſt Obſervation.	N.	S.	E.	W.
On Tueſday Sept. 8th. —		74		14
On Wedneſday 9th. ——		82		8
On Thurſday 10th. ——		74		18
On this Day as above —		95		16
		325		56

Here the whole difference of latitude is 325, and departure 56.

Then 325(560,000(.1723 = Natural Tangent of 9.47 the courſe made good ſince the laſt obſervation.

My courſe found by dead reckoning ſince the laſt obſervation being S. 9.47 weſterly, which is leſs than 33 degrees, we are to correct it by Caſe Second, and to find every thing excepting the diſtance, as follows.

First.

First, for the true difference of latitude.

Take the latitude by the laſt obſervation	41 .08
And the latitude by obſervation to day	35 .31
Gives the difference of latitude to day	5 .37
Which multiplied by 60 makes	337

Secondly, For the true courſe.

The courſe by D. R. ſince the laſt obſervation being S. 9 .47 W. We ſet it down for the true courſe, as by rule in caſe ſecond,

Third, for the true departure.

With the true courſe 9 .47, and the true × of latitude 337, we find the departure by the ſecond caſe of plain ſailing.

As S. C. C. 80 .13 : × of lat, 337 : : S. C. 9,47 : depart. 58.1 for the true departure.

Fourth, For the meridian diſtance.		Fifth, for diff. of longitude,	
Take mer, diſt, of laſt Ob,	504	Take mer, parts of laſt Ob.	2712
And the true departure	58	And mer, parts of to day's ob.	2282
Gives the mer, diſt, to day	562	Gives the mer, diff, of lat,	430

T, R, 45 : M. × lat, : : T, C, 9,47 : diff. long. Hence the difference of longitude corrected is 74.

Again by Middle latitude. As S, C, M, lat, 51 ,41 : dep, 33 : : Rad, 90 ,00 : difference of longitude 74

Sixth, To find the long, made,		*Corrected.*	
Take long, made laſt ob,	12 ,05	Courſe	S, 9 ,47 W.
And the whole diff, of long,	1 ,14	Diſtance	
Gives the longitude made	13 ,19	difference of latitude	337
		Departure	58 W.
		Latitude dead R,	35 .43
Seventh, for the lonitude in,		Latitude obſervation	35 ,36
Take long, in laſt obſ,	15 ,53	Merid diſtance	562 W,
And whole diff, of long,	1 ,14	Longitude made	13 ,19 W.
Gives the longitude in	17 ,07	Longitude in	17 .07 W.

Theſe to be found again as follows, courſe S. 9 .13 W. diff. of lat, 187 miles, departure 17 W,

The courſe, difference of latitude and departure as above, being what has been made ſince the laſt obſervation (which was four days ago

ago) and as it is uſual to ſet them down only as they are made from noon to noon, therefore they are to be rubbed out and found again as follows,

Firſt, take lat, D R, yeſt,	37 ,13N
And the lat, obſ, to day	35 ,31N
Gives the diff, of lat,	1 ,42
2dly. take yeſt, mer, diſt,	544 W
Mer, diſt, to day	562 W
Gives the departure	18

Then with the diff. of lat. 1.42 (or 102) and the departure 15 we find the courſe and diſt, by the 6th, caſe of plain ſailing as under,

102)18,0000(,1682 = N, T, 9 ,13 the courſe corected,
The S, C. 9 ,13 : dep. 18 : : Rad, 90 ,00 : diſt, 112,4 the diſtance,

H.	Courſes	knts.	h kt.	Winds.	Lee way.
2	S. by W	5		North,	
4		5			
6		6	1		
8		7	1		
10		7	1		
12		8	1		
2		8			
4		8			
6		8	1		
8		8	1		
10		9			
12					

TRANSACTIONS.

Saturday Sept. 12, 1772.

By reckoning I make my courſe from the Start to the iſland Madera S, 32 ,00 w, diſtance miles, or leagues, meridian diſt, and diff, of long, as underneath.

At noon ſaw the iſland of Madera bearing S, w, by w, diſtance 14 leagues.

Variation 00

Courſes corect.	diſt.	N.	S.	E.	W	× long	M.D	lat. Ob.	lat.d. r.	long. in
S. 16 .16 W.	215		2C		71	95	633		32 .14	18 ,32

Numb.	Courſes	Diſt.	P.	N.	S.	E.	W.
1	S. by W.	182	1		178.4		35.6
2	S. W. by W.	42	5		23.3		34.9
Difference of lat. 202		Dep. 71			201.7		70.5
							20,1

201,7)70,50000(.3495 = N. T, 19 ,16 the Courſe
As 19 ,16 : 70.5 :: 90 ,00 : 215 the diſtance

Lat Obſ, 35 ,36 S.	m, d, 562	To find the difference of long,
Diff, of lat, 3 ,22 S,	Dep, 71	202 : 71 :: 242 : 85 | 60)85(1 ,25
Lat. come to 32 ,14 S	D, R, 633	Courſe S. 19 ,16 W.
made good from the Start Point		Diſtance 215 miles
		× of latitude 202 miles,
Lat, dep. 35 .36	M, P, 2287	Departure 71 W.
Lat, come to 32 ,14	M, P, 2045	Latitude D. R. 32 .14 S,
		Mer, diſtance 633 W,
Meridian diff, of lati,	242	Longitude made 14 ,44 W,
		Longitude come to 18 ,32 W,

Note, the method uſed by the officers in the Royal Navy, to find the difference of longitude is by the traverſe table, thus by mercater the courſe here being 19 ,16, which is nearly one point and three quarters, then the mer, diff, of lat, 242 devided by 3 as being too big for the table, gives 81, which ſought for in the column of lat. under 1 point and three quarters, you will find 28,6 in the dep. anſwering thereto, and 28,6 × 3 = 85,8 the difference of longitude required.

It being cuſtomery upon making the land, to find what courſe and diſtance the ſhip has made by reckoning from the place ſailed from, to the place arrived at, which is thus performed.

Caſe 1ſt. When you keep the account of longitude in, with the latitude and longitude of the place you ſailed from, and the latitude and longitude the ſhip is in by your reckoning on the day you make the land, find the proper diff, of latitude, the mer. diff. of latitude, and the diff, of longitude in miles; and with them find the courſe and diſtanee by the firſt caſe of mercator ſailing before given,

Caſe 2d, When you keep the account of longitude made, then the the proper diff, of latitude, and the meridian difference of latitude are to be found as before, and the difference of longitude is to be found by bringing the longitude made into miles, with which proceed as in the firſt caſe,

The agreement between theſe two ways are ſeen as follows,

On the 12th of *Sept*, when I made land my long, in, was 18 ,32 W	On the ſame day our longitude made was 14 ,43
long, Sart, or where I dep, 3 ,47 W	Which multipied by 60
The difference of long, 14 ,45	
Which multiplied by 60	Makes diff, of long, 883 m,
Makes 883	the ſame as the other caſe

To

To find the bearing and diſtance of any place from the ſhip upon any given day.

Example, Suppoſe I would know how Madeira bore off me, and what diſtance on September 7th, by the foregoing journal?

Then with lat. Obſ.	41 .08N	M. P.	2712	Long. in	15 ,53 W.
And lat. Madera	32 ,44N	M. P.	2080	Long. made	17 ,26 W.
	8. 24		632		1 ,33

multi. 60 is equal 504 — makes 93 miles

Then as mer. diff. of lat. : × of long. :: proper × of lat. : × mer.
632 : 504 : : 93 : 74,2 meridian diſtance.

As × of lat. : R. : : dif. of mer. : T. Courſe,—504 : 45 ,00 : : 74 : 8,22

Here the courſe is found to be S. 8 ,22 w, and diſtance 508 miles

Having in the foregoing journal, ſhewn how to correct, either for a ſingle day or for a longer time, and given examples of every caſe, for correcting from one obſervation to another; but as it may happen that you may be ſome days at ſea, from your leaving the land, before you have an obſervation, and that when you get the firſt obſervation, you may have occaſion to correct; and there being much the ſame difference between working the correction from one obſervation to another and between the firſt obſervation and the land, as there is between working the the firſt days work and any of the following ones; I ſhall here give an example from the foregoing journal.

On the 27th of Auguſt, I was by obſervation in latitude 45 ,10 N, my latitude by Dead reckoning being 45 .23 N, my ſouthing by dead reckoning being 95 and weſting 24.

Now being to correct, and having no obſervation before to day, I muſt correct from the very beginning of my journal, that is, from the time of my leaving the land, by bringing the northing, ſouthing, eaſting, and weſting for every day I have been at ſea, into a traverſe table as follows.

By dead reckoning from the time of leaving the land.			N.	S.	E.	W.
On the firſt day	——	——		93		53
On the ſecond day	—	——		96		61
On the day I corrected	——	——		95		24
Whole difference of lat. by D. R.		284		284		138
Whole departure		138				

The

The difference of latitude and departure thus found, gives the course by D. R. from the time of leaving the land S. 25 .55 or 26 .00 W. and the course being less than 33 .00 I am to correct by case the 2d. and to find every thing except the distance as follows.

First, For the true difference of latitude.

Take the latitude of the place sailed from	50 07 N.
And the latitude in, by Observation	45 ,10 N.
The difference of latitude	4 ,57 or 297 m.

Secondly, for the true Course.

The course by D. R. since the time of leaving the land, being S. 25 .55 westerly, we set down for the true course, as by the rules of correcting in case second.

Third, for the true Departure.

As S. C. C. 64 .00 : × lat. 297 : : Rad 90 .00 : Dist. 330,4

As R. 90 ,00 : Dist. 330,4 : : S. C. 26 ,00 : Dep, 144,8 the true departure,

Fourth, for the Meridian Distance.

When ever you correct from the time of our leaving the land, (as you do here) the meridian distance will always be the same, as the departure found by correcting, which in this case is 145 W,

Fifth, for the difference of longitude: This I shall find both by Mercator and middle latitude as follows,

Latitude departed from 50 ,07 N,	As S, C, m, lat. 42 ,22 : dep, 145 : : R. 90 ,00 : × long. 215.1 miles = × of longitude.
Latitude by observation 45 ,10 N,	
Sum 95 ,17	Meridian Parts 3485
	Meridian Parts 3044
Middle latitude 47 ,38	Meridian × of lat. 441 m:
Co, mid, lat, 42 ,22	As T R. 45 ,00 : M. × lat. 441 : : T.C. 26 ,00 : × of lon, 215.8

Sixth, For the Longitude made.

When ever you correct from the time of your leaving land, as you do in this case, then the longitude made will always be the same, as the whole × of longitude found by the correction, which in this case is 215 miles. eqaul 3 .35 W.

Seventh, For the Longitude in.

To the Longitude sailed from	3 ,47 W.
Add the × of longitude	3 ,35 W.
The sum is the longitude in	7 ,22 W.

A Collection of Queſtions to exerciſe the foregoing Work.

Queſtion 1ſt. Suppoſe a ſhip ſails from a certain port between the ſouth and weſt, and finds the diſtance and difference of latitude in one ſum = 160 miles, and her departure 60 miles; required to find her courſe, diſtance, diff. of latitude and departure ſeverally?

The Geometrical Conſtruction.

Make A C = 160 miles the ſum of the diſtance and difference of latitude, and at C erect the perpendicular C d = 60 miles, being laid from C to *d*, the given departure; and draw the line A d, which biſect in the point g, and from g erect the perpendicular g b cutting A c, ſome where in b, and from b, draw b d, and the figure is finiſhed; whence b c, is the difference of latitude, b d the diſtance, and d c the departure, and ∠ d b c the courſe.

The Demonſtration.

For the triangles A g b, and g b d, are alike and equal (p.24.E.1.) becauſe A g = g d by conſtruction, and g b, is common to both triangles; whence d b=A b, and the ∠ g A b=½∠ g d b,(p.23. E.1.) therefore the ∠ at half g A b, is juſt half the angle of the courſe from the meridian; and from hence we may form this general proportion for the ſolution of all queſtions of this nature; viz. As the ſum of the diſtance and difference of latitude: to Radius : : So is the departure to the tangent of half of the ſhip's courſe, the ∠ doubled is the courſe

Than as ſum diſt. and × of lat. : T. Radius : : dep. : T. ∠ d A C. 160 : 45,00 : : 60 : 20,34 doubled is = 41,08 the courſe.

Secondly, As S. Courſe : departure : : So is Radius : diſtance. S. 41,05 : 60 : : 90,00 : 91,21 the diſtance.

From	160,00	Hence the difference of latitude 68 79, the diſtance 91,21 and courſe S. 41,08 W.
Subtract	91,21	
Remains	68,79	

Solution Algebraicaly.

Let a = 160 Sum of the diſtance and × of latitude b = 60 = the departure x = diſtance and $a - x$ = difference of lat; and (p. 47 E. 1) $x^2 a + 2a^2 x - x^2 = b^2$ Then by tranſpoſition and diviſion $x = \frac{a^2 + b^2}{2a}$ = 91,25 the diſtance, and $a - x$ = 68,75 the difference of latitude, the courſe is found equal 41,08 the ſame as before.

Queſtion

Queſtion 2d. Suppoſe a ſhip ſails from the tropic of Cancer, between the ſouth and eaſt, and finds her latitude by obſervation to be 12 ,24 N, and her diſtance and departure in one ſum is 666 leagues or 1998 miles; I demand her courſe ſteered, with her diſtance and departure ſeverally.

The Geometrical Conſtruction. Pl. 2. Fig. 97

Make the line B D equal 666 leagues = ſum of the diſtance and departure, and make A B perpendicular to B D, and lay 222 leagues from B to A, equal the difference of latitude and draw the line A D, which biſect in the point F, and draw F C perpendicular to A D, which will cut the line B D in the point C; then A C will be diſtance, B C the departure, and demonſtration the ſame as before.

Trigonometrical Calculation.

In the right angled triangle A B D, we have the ſide A B, equal 222 leagues, and the ſide B D equal 666 leagues, to find the angle A D B equal,

		As the ſum of diſt and dep.;
From	23 ,30	T. R. : : × of lat. : T. ∠ ADD.
Subtract	12 ,24	666 : 45 ,00 : : 222 18 ,26 which
		doubled is 36 ,52 the ſhip's courſe
Difference of latitude	11 ,06	190 ,00—36 ,52=53 ,08 =S,C.

Then S. C. C. 36 ,34 : 222 : : 90 ,00 370 leagues, conſequently the courſe is S. 53 ,08 Eaſterly, or S. E. 3 quarters E, neareſt; diſt. 370, and departure 296 leagues, as required.

Queſtion 3d. Suppoſe a ſhip ſails in the S. W. Quarter. from a port in the north latitude until her diſtance be 120 miles, and the ſum of her difference of latitude and departure 169 miles; Required to find her courſe, difference of latitude and departure.

Solved Algebraically.

Let the diſtance A C = a = 120 and the ſum of the difference of latitude and departure = b = 160. and x = of latitude, and $b - x$ = the departure then (p. 47 E. 1) $2x^2 - 2bx + b^2 = a^2$ which gives this theorem $x = \frac{1}{2}b \pm \sqrt{\frac{1}{2}x^2 + \frac{1}{4}b^2}$ } 108 ,3 departure
51 ,7 × of latitude

Then as diſt, 120 : Radius 90 ,00 : : Dep. 108 : S. courſe 64 ,10 whence the courſe S. 64 ,10 weſterly, difference of latitude equal 52 and departure 108 miles as required.

The Theoram in Words.

From half of the ſquare of the diſtance, ſubtract the fourth part of ſquare of the given ſum of the difference of latitude and departure, and the ſquare root of the remainder added to half the ſaid ſum gives the departure, and ſubtracted from the ſaid half ſum gives the difference of latitude.

Queſtion 4th. Suppoſe a ſhip ſails N. E. by N. from the latitude 90 ,00 N. till her diſtance, difference of latitude and departure, in one ſum is 600 leagues; I deſire to find what they are ſeverally, with the latitude come to?

Geometrical Conſtruction. Pl, 3d, Fig. 98

Firſt draw the line A B C D, equal 600 leagues, and from A, draw A E to make with A D an angle of 16 ,52, equal to half the given courſe; alſo from D, draw D E, to make with A D an angle of 45 ,00 at D, and continue D E till it cut A E in E; from E, let fall the perpendicular E C upon the line A D, divide A E into two equal parts in G, and draw G B perpendicular to A F, to cut A D in B, and draw B F, and the projection is done, and B E C, is the triangle required.

Arithmetical Calculation.

Here we may obſerve that the angle G E B equal angle G A B, is equal half the angle of the courſe B E C equal comp. courſe, and C E D, equal 45 ,00, and theſe three include the angle A E D, from whence is deduced this general proportion for all queſtions of this kind; Add half the courſe, the comp. courſe, and 45 ,00 together, then

As the S. of the ſum of theſe angles, is to the ſum of three ſides, ſo is the S. of half the courſe to a fourth term.

And as Radius is to the fourth term. ſo is S. 45 ,00 to the departure; the courſe being given, and the departure thus found, the reſt is found by the common caſe in plain ſailing as followeth.

Half courſe $\frac{33\ ,45}{2}$ =	16 ,52	As S. angle A E D, 118 ,07 (61 ,53) is to ſide A D 600. ſo is S. angle A 16 ,52 to ſide E D 197.4 equal E D.
Comp. Courſe	56 ,15	
∠ C E D = E D C	45 ,00	
Sum is angle A E D	118 ,07	

Then in triangle E C D.

As Radius 90 ,00 is to ſide D E, 197.4, ſo is S. angle E D C 45 ,00 to ſide E C 139,6

Third,

Third, In the triangle E B C is given the courſe E B C 33 45, and departure E C equal 139,6, to find the diſtance and difference of latitude.

As S. C. 33 ,45 is to dep. 139.6 ſo is Radius 90 ,00 to diſt, 251,2.

Radius 90 ,00 is to diſtance 251.2 ſo is S. C. C, 56 ,15 to × of latitude 208,9; hence it appears, the diſtance is 251, × of latitude 209, and departure 140 as was required.

Queſtion 5th. If A ſhip ſails S, W, by S. from the latitude 46 ,27 north, until her diſtance be 160 miles more than her difference of latitude; I deſire to know her diſtance, difference of latitude and departure ſeverally.

Geometrical Conſtruction. Pl, 3d. Fig. 99.

Draw the line A B at pleaſure, and at A make the angle C A B equal 56 .15, and make A D equal 160, and draw D B to make with A D an angle of 106 ,53 to cut A B in B, and on the point B, erect the perpendicular B C to cut A D produced in C, then is A B C the triangle required.

Trigonometrical Calculation.

Firſt, In the triangle A D B, here is all the angles, and one ſide given, viz. the angle A 56 .15, the angle D is 106 .53. and angle B 16 ,52, and A D 160, to find A B the departure.

N.B. In conſidering of the conſtruction aforeſaid, line B D, cuts off an iſocles triangle B C D, whoſe vertical angle C, being 33 ,45, which taken from 180 ,00 leaves 146 ,15. half thereof being 73 ,07, for each of the = angles C D B or C B D; hence 180,00 — 73,27 equal 106 ,53 equal angle A D B.

As S. angle B 16 ,52 is to ſide A D 160 ſo is S angle D 106 ,53 to ſide A B 528.

As Radius 90 .00 is to diſt, 950 ſo is S C C 56 ,15 to × lat, 790

As S C 33 ,45 is to × of lat, 528 ſo is Radius 90 ,00 to diſt, 950

Anſwer, diſtance 950 miles, difference of latitude 790, and departure 528 miles as required.

Queſtion 6th. If a ſhip ſails N, eaſterly 600 miles, and then her departure is 120 miles more than her difference of latitude; I deſire to know what is her courſe, difference of latitude and departure.

Geometrical

Geometrical Conſtruction. Pl. 3d. Fig. 100

Make the diſtance A B equal 600 miles, which biſect in the point E, and let fall the perpendicular E O, then draw the obſcure A O to make with A B, an angle of 45 ,00 cut E O in O, then upon O as a center, deſcribe the ſegment of a circle A D B, in which deſcribe A B equal 120, the given ×, between the × of lat. and departure, and produce A B at pleaſure, then draw the line B D, and make the angle D B C equal angle C D B, then will A B C be the triangle required. Wherein A C is equal the departure, and B C equal the difference of latitude.

The Demonſtration.

The angle C D B equal angle C B D by conſtruction, therefore C D equal C B, and A C — C D equal A B, alſo ſince C B D equal B D C. and C equal A D B — C D B (p. 31 Ex 1) therefore will C equal A D B — C B D equal Radius or the angle given; becauſe A D B being greater than a right angle by half the given angle, C D B muſt be leſs than a right angle by the ſame quantity, and ſo the difference of the angles A D B and C D B equal the whole given angle.

Trigonometrical Calculation,

As ſide A D, is to S, angle A D B, ſo is ſide A D to S angle A B D *i, e,* 600 : 135 ,00 (45 ,00) : : 120 : 8, 08

To the angle	45, 00
Add angle	8, 08
Sum equal angle C B A	53 ,08

Then ſay, as Radius 90 ,00 is to diſtance 600 ſo is S, angle A B C 53 ,08 480 the departure,

From	480
Subtract	120
Remains	360

From whence the courſe N, 53 08 eaſterly or S, E, 3 quarters E, neareſt, difference of latitude 360 miles, and departure 480 miles

Queſtion 7th, Suppoſe a ſhip ſails W, S, W, from the latitude 40 ,20 N, and then finds he diſtance to be 90 miles more than the departure; I demand the diſtance, difference of latitude, and departure, and what latitude ſhe is come to?

The Geometrical Conſtruction, Pl. 3d, Fig. 101

It evidently appears from a ſimilar figure that the angle B C D equal 22 30 and the ſides B C and D C being equal their oppoſite angles, viz, C B D and C D B are alſo equal; From 180 .00 ſubtract 22 ,30 Remains 157 ,30 half thereof being 78 ,45, then 180 ,00 — 78 45 equal

equal 101 ,15 equal angle A D B, and 90 ,00 —78 ,45 —11 15 equal angle A B D hence we have angle B A D equal 180 ,00 — 101 ,15 — 11 ,15 equal 67 30. Then by Trigonometry.

As S, angle A B D 11 ,15 is to A D 90 ,00, ſo is S angle A D B 78 ,45. to A B 452,4 the X lat,

As R, 90 ,00 is to diſt, 1182 o is S, C, 67 ,30 to dep, 1092

As S, C, C, 22 ,30 is to Radius 90 ,00 ſo is X of lat, 452,4 to diſt, 1182 the Diſtance,

Anſwer, diſtance 1182, X of latitude 452,4, departure 1092

Queſtion 8th, Suppoſe a ſhip ſails from the latitude 50 ,00 N, in the S, W, quarter 153 miles, and then finds her difference of latitude to exceed her departure by 30 miles; I demand her courſe, difference of latitude and departure ſeverally.

The Geometrical Conſtruction. Pl. 3d. Fig. 102

It plainly appears from the figure, that the triangle B C D, is right angled and iſocles, the two ſides B D and B C being equal, their oppoſite angles are alſo equal as before recited, hence the angle B D C equal angle B C D equal 45 ,00, then from 180 ſubtract 45, remains 135 ,00 equal A D C, then make A D equal 30, and on D make the angle A D C equal 135 00, and draw the line D C at pleaſure, then from the ſame ſcale of equal parts, take 153 in your compaſſes, and one foot in A, cut the line D C, and let fall the perpendicular C B on the line A D produced, and draw A C, and the figure is finiſhed; for A B is the departure, and B C the difference of latitude required.

As diſt, A C 153, is to S, angle A D C 135 ,00 (45 ,00), ſo is ſide A D 30, to S, angle A C D 7 ,58

As Radius 90 ,00, is to diſt, 153, ſo is S, courſe 37 ,02 to departure 92,1 the departure.

As Radius 90 ,00 is to diſt, 153, ſo is S, C, courſe 52 ,58, to X of latitude 112,1 the diff, of lat.

To	45 .00
Add	7 ,58
Angle A C B	52 ,58

Queſtion 9th, If the ſhip ſails in the S, W, quarter, till her diſtance is 200 miles more than her difference of latitude, and her difference of latitude is 96 miles more than her departure; I demand her courſe, diſtance, difference of latitude and departure ſeverally.

Anſwered Algebraically.

Let *a* equal 200, the difference between the diſtance and difference of latitude *b* equal 96 the difference between the difference of latitude and

and departure; and put x for the departure, then the difference of latitude will be $x + a$, and the diſtance will be equal $x + a + b$, then by (p. 47 E. 1) we have this equation $2x^2 + 2xa + a^2 = x^2 + 2ax + 2bx + a^2 + 2ab^2$ and ſubtracting from both ſides $x^2 + 2ax + x^2$ we have x^2 equal $2bx + 2ab + b^2$, wherefore fore by the firſt caſe of adfected equations x equal $b + \sqrt{2ab + 2b^2}$ equal 344 ,093 equal the departure; then $x + b$ equal 640 ,093 equal ✕ of latitude, and $x + a + b$ equal 840 093 the diſtance,

For the Courſe.

As the diſtance 140 ,093 : is to Radius 90 ,00 : : departure 544 ,093 : to S. courſe 40 ,23, that is S. 40 ,22 weſterly.

The Geometrical Conſtruction. Pl. 3, Fig. 103

The conſtruction of this caſe, viz. $x^2 + 2bx$ equal $2ab + b^2$ is thus, draw the line A B at pleaſure, and thereon ſet $2a$ equal 400 on the remote end thereof, erect a perpendicular equal $\sqrt{2ab + b^2}$ then upon the center of the given line, viz. 200, deſcribe the ſemi circle which cuts the diameter in A and B, the root of the given quadratic is repreſented by x equal A B, and $x - 2b$ equal bB from whence the anſwer is eaſily found, diſtance equal 840 ,093, ✕ of latitude 640 ,093 and departure 544 ,093.

Queſtion 10th, Suppoſe a ſhip ſails from the equator in the N. E. quarter, and for every 50 leagues ſhe runs ſhe differs her latitude 40 leagues, and thus ſhe continued her ſailing till her departure was 80 leagues; I deſire to know the ſhip's courſe and diſtance, and latitude ſhe is come to?

The SOLUTION, Find the Courſe and Diſtance to the ſimilar Triangle, whoſe Diſtance is 50, and ✕ of Latitude 40 leagues.

As the Diſtance	60	As Radius	90 ,00
Is to Radius	90 .00	Is to her diſtance	50
So is ✕ of latitude	40 ,00	So is S. courſe	36 ,52
		To the departure	30
To S. C. Courſe	53 ,08		
Subtract from	90 ,00	30 : 50 : : 80 : 133 ,333 diſt.	
		30 : 40 : : 80 : 106 ,666 ✕ lat.	
Remains S. Co.	36 ,52	The courſe is N. 36 ,52 eaſterly.	

Diſtance 135 ,533 leag, ✕ of lat, 106,6 leag, the anſwer required.

Queſtion 11th, Suppoſe a ſhip ſails in the S. W. quarter, from a certain road in latitude 3 ,33 S. and for every 7 leagues ſhe runs, ſhe departs from the meridian 4 leagues, and ſo ſhe continues ſailing till ſhe

ſhe arrives in the latitude 17 ,39 S; required to find her direct courſe, diſtance and departure ſeverally, by plain ſailing.

From	17 ,39 S,	From	90 ,00	From	34 ,51
Subtract	3 ,33 S.	Subtract	34 ,51	Subtract	33 ,34
	14 ,06	C. Courſe	550,9	Remains	1 ,06
	20				
× lat.	288 lea.				

As diſtance 7 is to Radius 90 ,00 ſo is dep. 4 to S. C. 34 ,51

As Radius 90 ,00 is to diſt. 7 ſo is S. C. Courſe 55 ,09 to × lat. 5,744. ſimilar triangle; then proceed with the ſides of the ſimilar triangle as follows.

As 5,744: 7:: 282: 43,66 the diſt.—5,744 : 4: :282: 196 ,36 dep.

Anſwer, her courſe S. 34 ,51 weſterly, or S. W. by S. 1.06 weſterly, Diſtance 343 .66 leagues, and departure 196 ,86 as required.

Queſtion 12th, Admit a ſhip ſails from a port in latitude 20 ,00 N. between the ſouth and eaſt, and for every three miles ſhe differs in latitude, ſhe departs from the meridian four miles, and thus ſhe continues till her diſtance run is 555 leagues or 965 miles; I demand her courſe, difference of latitude, and departure, and latitude come to?

Solution. As × of lat. 3 : T. R. 45 ,00 : : dep. 4 T. cou. 53 ,08

The S. courſe 53 ,08 : dep. 4. : : Radius 90 ,00 : 5 proportional diſt.

Then 5 : 4 : : 555 : 444 leagues— and 5 : 3 : : 555 : 333, From whence it appears that the courſe is S. 53 .08 eaſterly, difference of latitude 333 leagues, departure 444 leag. and latitude come to 3,81 N.

Queſtion 13th. Suppoſe a ſhip ſails from a certain port in north latitude 12 ,55 N. between the ſouth and weſt, till her diſtance is 342 leagues more than her departure, and 145 leagues more than her difference of latitude; required her courſe, diſtance, difference of latitude, departure and latitude come to ſeverally.

Arithmetical Calculation.

Let the greater ſide be x = × of latitude a 342, $b = 145$, then the diſtance will be $x + b$, and the departure is repreſented by $x + b - a$, then (p. 47 E. 1.) $2x^2 - 2ax + 2bx + b^2 - 2ab + a^2 = x^2 + 2bx + b^2$ that is the ſum of the ſquares of the difference of latitude and departure is equal to the ſquare of the diſtance

and deſtroying $x^2 + 2b2 + b^2$ from the equation and we have $x^2 - 2ax - 2ab + a^2 = 0$ this equation gives x equal $\sqrt{2ab} + a$ equal 656,93 the difference of latitude, and 659,92 + 145 equal 501,92 the diſtance, and 801,92 — 342 equal 460,02 the departure. Then for the courſe, Say as the difference of latitude 660 is to Tangent Radius 45,00 ſo is the departure 460 to the Courſe 34,46, from whence the diſtance is 802, × of latitude 657, departure 460 leagues, courſe S, 34,46 weſterly, and latitude come to 20,05 S. as was required.

The Geometrical Conſtruction. Pl. 3, Fig, 103

Between the given differences in the queſtion find a mean proportional D F by making B D equal 342 and D E equal 145, and erect the perpendicular D E at pleaſure, then upon E B deſcribe ſemi circle E F B, cutting D E in F, then is F D the mean proportional and perpendicular thereto, make the line F G equal F D, and cut of D H equal D G, and ſo B H will be the × of latitude in this queſtion, this being prolonged to C that C H may be equal to D E, then upon C B deſcribe the ſemi circle, apply therein B A equal B H, then B C is the diſtance, and A C the departure required.

Queſtion 14th. A maſter of a ſhip ſailling towards the eaſt, hath forgot his courſe, yet this much he knows, that if he ſailed on his true courſe 108 leagues he ſhould have raiſed the pole 2,51, and have been much more diſtant from the meridian than now he is, and alſo ſhould have been 57 miles more northerly; I demand his courſe, diſtance and departure.

The SOLUTION,

In the right angled triangle A B C, here is given A B the difference of latitude 2,51 equal 171 miles, A C 108 leagues equal 324 miles, the ſuppoſed difference of latitude and diſtance given, to find B C the ſuppoſed departure.

As ſuppoſed departure 324, is to R. 90,00, ſo is ſuppoſed × of lat. 171, to S, C. courſe 31,52.

As R. 90,00 is to diſt. 324 ſo is S. courſe 58,08 to ſuppoſed dep. 275.

Hence the ſuppoſed departure is 275 miles and $\frac{275}{2}$ equal 137.5 m. the true departure, and 171 — 57 equal 114 miles the true difference of latitude, then find the true courſe and diſtance by the 6th caſe of plain ſailing.

As × of lat. 114 is to T.R. 45,00 ſo is dep. 137,5 to T. courſe 50,20

As

As S. course 50,20 : dep. 137,5 : : Radius 90,00 : distance 179

Answer, Course N. 50,20E. or N. E. half E. nearest, distance 179 m, × of latitude 119, and departure 137,54.

Question 15th, Suppose a ship sails from an island in latitude 4,00 S. N. E. by N. until she comes into the latitude 4,00 N. I demand her distance and departure to and from the equator. Pl. 3d. Fig. 107.

Solution, 90,00 — 33,45 = 56,15 4,00 = 240 m. = 80 lea.

As S. C. course 56.15 : × of lat. 80 : : Radius 90,00 : dist. 96,2

Radius 90,00 : dist. 96,2 : : S. course 33,45 : dep. 53,44

Answer, Distance 96,2 departure 55,4 leagues to and from the equator.

Question 16th. Suppose two ships sails from the Tropic of Cancer, the first sails S. W. the other S. E. the first sailed 665 leagues, and the other sailed to the equator; I demand the first ship's × of latitude and departure, and the second ship's distance and departure severally.

To find the first Ship's × of Latitude and Departure. Pl. 3d, Fig. 108

As Radius 90,00 is to dist. 665 so is S, C. 45,00 to departure 470

Hence her difference of latitude, and departure each equal 470 leagues or 23,30, so that the first ship is also come to the equator, the second ship's distance also being 665 leagues, and each ship's × of latitude and departure equal 470 leagues as required.

Question 17th, Admit four ships sails from one port on the equator, the first sailed N. W. the second N. E. till they came to the Tropic of Cancer, the third sailed S. E, the fourth S. W. till they came to the Tropic of Capricorn, and were then asunder 940 leagues; required each ship's distance and departure severally. Pl. 3d. Fig. 109

The SOLUTION. By the question it appears that each ship's difference of latitude is 23,30 or 1410 miles, equal 470 leagues, and each ship being 940 leagues distance from each other, their difference of lat. and depar. being equal, and each = 470, then $\sqrt{470 \times 470 \times 2}$ 665 leagues, the distance sailed by each ship, as was required.

Question 18th, Suppose a master of a ship coming to an anchor, and would moore his ship, having ninty-five fathom to his small bower cables service, and found thirty-five fathom of water, the buoy bearing up

up and down; I desire to know how much of the best bower cable he must veer out to bring his small bower service in the hause, when the ship is hove up again and moored. *Pl, 3d. Fig.* 110,

The SOLUTION. By the question D E equal 95 and A E equal 35, then $\sqrt{93^2-55^2}$ equal 88 the distance of the buoy from the ship at D, then 88 × 2 equal 176 equal A B and 176 × 176 equal 30976, hence $\sqrt{30976-1225}$ equal 176 fathoms the length of the best bower cable to be veered out, whence the ship is hove up and moored.

Question 19th, Suppose three ships are all bound to one port, one ship is in latitude 20,00 N. the second in latitude 30,00 and the third in latitude 40,00 N, and the port lies in latitude 50 00 N. and they all sailed one distance, viz. 740 leagues; required their several courses and departures.

SOLUTION. In the figure is given the triangle A B G, representing the first ship's course and departure, and distance common to all the three ship's, and in each triangle is known the distance and difference of latitude, to find the course and departure as follows.

First ship's × of latitude 30,00 equal 600 leagues, second ship's difference of latitude 20,00 equal 400 leagues third ship's difference of latitude 10,00 equal 200 leagues.

For the first Ship's Course and Departure. Pl, 3d Fig. 111

Then As distance 740 : Radius 90,00 :: × lat. 200 : S. C. C. 54,11

And as R. 90,00 is to dist. 740 so is S. C. 35,49 to departure 433,2

For the second Ship's Course and Departure.

As dist, 740 is to R. 90,00 so is dif. of lat. 400 to S. C. C. 32,43

As Radius 90,00 is to dist, 740 so is S. C. 37,17 to departure 622,6

For the third Ship's Course and Departure.

As dist. 740 is to R. 90,00 so is dif. of lat. 200 to S. C. course 15,41

As Radius 90,00 is to dist. 740 so is S. C. 74,19 to departure 712,5

Souther-most ship's course N. 35,49 westerly, and departure 433 legues; middle-most ship's course N. 57,17 westerly, and departure 622,6; Norther-most ship's course N. 71,25 westerly, departure 712,5 leagues.

Question

Queſtion 20th, There were three flags ſet ſail, the Albemarle, Union, and Namur, from port Mahoan in latitude 39 ,55 N. with four ſhips of war more, viz. the Cornwal, Oxford, Revenge, and Torbay; the Albemarle ſailed north, the Union ſailed N, E. by N. and Namur eaſt, each 85 league, the Cornwal ſailed N. E. by N. until ſhe made a tangent with the Albemarle, the Oxford ſailed alſo N. E. by N. until ſhe made a tangent with the Namur, the Torbay north and the Revenge eaſt, until they made fines with the Union; now I demand each ſhip's diſtance, difference of latitude and departure, the flags being the Radius. Pl. 3d. Fig. 112

SOLUTION. As R. 90 ,00 is to ſide A c 85 ſo is S, ∠ A 33,45, to perpendicular *e* c 47 ,22.
As R. 90 ,00, is to diſt. A c 85, ſo is S, ∠c 56 ,15, to baſe A c 70,67

As T,R. 45,00, is to hyp. A c 85, ſo is T, ∠ A 33,4, to p. b, B c 56,8

As R. 90 ,00 is to hy. A c 85 ſo is ſect. ∠ A 33 ,45 to h. A c 102,2	*Anſwer*	leag.
	Revenge ſailed	47,22
	Torbay ——	71
As T. R. 45 ,00 is to h. A c. 85	Oxford —— ——	153
ſo is T. ∠ c. 56 ,15 to p. D *d*. 127,2	Her difference of lat.	127
	Cornwal's diſtance	102
As R. 90 ,00 is to hyp. A c 55	Her departure	57
ſo is S. ∠ c 56 ,15 to h. A D. 153	as was Required.	

Queſtion 21ſt, There are two ports A and c, both in the ſame latitude 45 ,00 N, A ſhip at the weſtermoſt A, ſails in the N, E, quarter, to another port B 45 miles, and then altering her courſe 90 degrees or eight points, ſails a certain diſtance between the ſouth and eaſt, and arrives at the other port c, and her depar. and eaſting from the ſecond port B, to the third port c, is 48 miles; I demand what latitude the port B lies in, alſo the courſe and diſtance from the ſecond port B to the third port c.

Let *a* equal her given diſtance to the port B, equal 45 equal A B, D c equal 48 equal *b* her difference of meridian from the ſecond port B to the third port c, then let A D equal *y*, the firſt departure and B D equal *x* the difference of latitude.

Then $\sqrt{b^2 + x^2}$ equal her laſt diſt. to the port c.

P. 47, El. 1 equal 2 Then here

1. $b : x :: x : y$, ∴ by $= x^2$
2. $a^2 - y^2$ equal x^2
3. $a^2 - y^2$ equal by, or $y^2 +$ by equal a^2
4. y equal $\sqrt{\frac{1}{4}b^2 + a^2} : - \frac{1}{2}b$ equal 27
5. A D is found equal 27 and

x equal $\sqrt{a^2 - y^2} = \sqrt{45^2 - 27^2}$ equal 36 = B D

And $\sqrt{36^2 + 48^2}$ equal 60 equal B c

As

As the distance B C	60	As distance	45
Is to Radius	90 ,00	Is to Radius	90 ,00
So is departure C D equal	48	So is departure A D	27
To S, course	53 ,48	To S, course	36 ,52
Her second course		Her first course	

Answer, The ship's casting from A to B is 27 miles, the perpendicular B latitude equal 45 ,36 N. course from A to B equal N. 35 ,52 easterly dist. from B to C equal 60 miles, course equal 53 ,08 Q.E.I.

Question 22d, Suppose a ship sails from a certain port at B in the latitude 44 ,00 N, she runs a certain distance, in the N, W, quarter, and then arrives at another port at C, in latitude 44 18 N. from the port C, she utters her course 90 .00 degrees, and sailed in the S, W, quarter a certain distance, which exceeds her former distance by 75 miles, and then arrives at another port A in the same latitude with the Port sailled from at B; required the distance asunder of the first and third ports B, and A, also the distance of the ports A and C, and C and B with the 1st. and 2d. courses and depar. DB and DA. severally.

Solution, Let a equal 18, the difference of latitude equal C D, b equal 7,5 the difference of their distances eqaul A b and x equal the sum of their departures A B, Pl. 3d. Fig. 114

	1	$b + y : a : : x : y$,
1 c, c	2	by $+ y^2$ equal $a x$,
Again	3	$b^2 + 2$ by $+ 2y^2$ equal x^2
2 + 2	4	2 by $+ 2y^2$ equal $2 a x$
3 — 4	5	$x^2 - 2 a x$ equal b^2

From the 5th. Equation we we get x equal $\sqrt{a^2 + b^2} + a$ equal 37 5 equal AB the sum of their departures, hence the square root of the sum of the squares of the difference of latitude and difference of distances sailed added to the difference of latitude, gives the sum of their departures; Again y equal $\sqrt{a x + \frac{b^2}{4}} + \frac{1}{2} b = 22,5$ C B in words is the square root of the product of × lat, multiplied by the sum of the departure, added to the fourth part of the square of the × of distances, and to this root add half the said distance gives 22,5, then find each courses as follows.

As B C 22,5 : Radius 90 ,00 : : × of lat. 18 : S, C, C, 53 07

Radius 90 ,00 is to dist. 22,5 so is S. C, 36,53 to dep. 13,5 = B D.

As dist, A C 30 is to Radius 90 ,00 so is × of lat. 18 to S. C C 36 52

Ar Radius 90 ,00 is to dist. 30 so is S. C. 53 ,07 to departure 24

Answer

Anſwer. The diſtance of the ports A and B. 37,5, diſtance B and C 22,5 miles, diſtance A C 30 from each other, firſt departure 13,5 ſecond departure 24, courſe from B to C, N. 36,53 weſterly, courſe from C to A, S. 53,07 weſterly, as was required.

OBLIQUE TRIGONOMETRY.

The Three other Axioms of Oblique Angled plain Triangles, and the ſix Caſes thereon depending.

Axiom ſecond, In all plain triangles, the ſides are in ſuch proportion one to another, as are the ſines of their oppoſite angles. That is,

As the ſine of any one angle : is to its oppoſite ſide : : ſo to the ſine of any other angle : to its oppoſite ſide.

As any ſide, is to its oppoſite angle, ſo is any other ſide, to its oppoſite angle.

Note, to find a ſide begin with an angle, and to find an angle begin with a ſide.

From this axiom are drawn the firſt and ſecond caſes, and their operations and proportions thereunto belonging.

Caſe 1ſt. In the oblique angled plain triangle A B C, there is given the angle A equal 31,19, the ∠ B equal 39,51, and the ſide A C oppoſite, equal 139 miles; I demand the ſides A C, and B D, and the third angle.

The Geometrical Conſtruction. Pl. 2. Fig. 118

Draw the baſe A B, and make the ∠ A = 29,51, and make the ſide A C = 139 mile., then make the ∠ C 118,50 or the ∠ D C B 61,10 equal the complement 118,50 to 180,00 and draw the ſide B C, which is the ſide required.

Angle A	31,19	From	180,00
Angle B	29,51	Subtract	61,10
Sum	61,10	Angle C	118,50

Menſuration Mechanically, meaſure AB and Bc, on the ſame ſcale of equal parts, you took A c from, and you will find A B 234 miles, and B c 133 miles.

Solution

Solution literal. } As ∠ B, is to A C, ſo is S ∠ C, to A B.
As S. angle B, is is to A C, ſo is S angle A, to CB.

Logarithmetically, By artificial Sines and Numbers, the proportion to find A B *and* B C *by the ſecond Axiom before going.*

		co, Ar,			co, Ar,
As S. angle B	29,51	0,303005	As S, ∠ B	29,51	9,303005
Is to ſide A C	139	2,143015	Is to ſide A C	139	2,143015
So is S. ∠ C.	118,50	9,942517	So is S. ∠ A	31,19	9,715809
To the ſide A B	244,7	2,388537	To ſide B C	145	2,161329

Inſtrumentally, by Scale and Compaſſes.

Extend from Sine 29,51 to S. 61,10 (ſupplement 118,50) on the line of ſines, that extent applied the ſame way from 139 on the line of numbers will give 244,7 the ſide A B.

Extend from S. 29,51 to S. 31,19, on the line of ſines, that extent applied the ſame way from 139 on the line of numbers will give 145,2 the ſide A B, as was required.

Arithmetically by the Table of Natural Sines.

N. S. 39,51 = ,4977
N. S. 61,10 = ,8760
N. S. 31,19 = ,5198

1ſt, Say, ,4977 : 139 : : 8760

·4977 : 139 : : ·5198
139

46782
15594
5198

4977)72,2522(145,2 nearly the ſide B C.
4977

22482
19908

25740
24885

8550
7954

139

78840
76280
8760

,4977)121,7640(244,7 for the ſide A B
9954

22224
49908

23160
19908

32520
29862

2658

Caſe

Caſe 2d. In the oblique angled plain triangle A B C, is given the ſide A B equal 244,7 yards, ſide A C equal 139 yards, the angle B oppoſite to the leſs ſide equal 29,51; required the angle C obliique, and the ſide B c.

Note, if the angle be obtuſe the angle ſought is acute, but when it is acute and oppoſite to the greater ſide, the required angle is acute, when it is acute and oppoſite to the leſſer ſide, the required angle is doubtful, whether acute or obtuſe, it ought to be determined before operation,

Geometrical Conſtruction. Pl. III. *Fig.* 119.

Draw the line A B, which make equal to 244,7 yards, 2dly, Make the angle B equal 29,51, and draw B C produced 3, with 139 in your compaſſes, and one foot in A, croſs B C produced in the points C and Q, and draw A C and A Q, ſo ſhall the angle A Q B equal (A C Q) in the ſuperior triangle will be acute, in the inferior triangle A C B, will be obtuſe, which with the ſide B C is required.

Menſuration Mechanical.

Meaſure the angle A C Q equal angle A Q C, and it will be 61,10, whoſe complement to 180,00 is the meaſure of the angle A C B equal 118,50 obtuſe, becauſe the outward angle A C Q, is equal to the ſum of the two inward and oppoſite angles, B A C, and A B C, and B C, meaſured on your ſcale of equal parts will give 145.2 yards as required

Solution literal } Side A C, : S angle B, : : ſide A B, : S angle A Q C, equal A C Q acute, and ſubtract from 180,00 gives A C B obtuſe,

Then S angle B, : ſide A C, : : S angle A, : ſide B C.

Operation Logarithmetical.

Angle C	118,50		
Angle B	29,51		co. Ar,
Sum angle	148.41	As ſide A Q 139	7,856985
		Is to S angle B 29.51	9,696991
Subtract from	180,00	So is ſide A B 244.7	2,388537
		To S ∠ Q acute 61,16	10,942513
Remaind. angle B	31,19		
As S. angle B	29,51	0,303605	
Is to ſide A C	139	2,143015	
So is ſide angle	51.19	9,715809	
To the ſide B C	145,2	2,162829	

Inſtrumentally by Scale and Compaſſes.

Extend the compaſſes from ſide 139, to ſide 244.7, on the line of numbers, that extent laid the ſame way from S. 29 ,51, will give S. 61 ,10 on the line of ſines, which taken from 180 ,00 gives 118 ,50 for the obtuſe angle C.

Extend the compaſſes from S angle B 29 ,51, to S angle A 31 ,19 on the ſines, that extent applied from ſide A C equal 136, on the line of numbers, will give 145,2, for the ſide A B required.

Arithmetically by Natural Sines.

As ſide A C 139 is to S angle B 29 ,51 N. S. 4977, ſo is ſide A B 244,7, : to ,87616, equal Natural Sine. angle A C Q, equal 61 ,10, which ſubtract from 180 ,00, remains 118 ,50, equal angle C, again ſay, As N, S, 29 ,51 equal 4977, is to ſide A C 139, ſo is N, S, angle 31 ,19 equal 5198, to 145,2 equal ſide B C. The Operation.

```
139 : .4978 :: 244,
      2447
     -----
     34839
     19908
     19908
    -------
139)1217.8719(17616 equal
    1112 ....  N. S. 61 ,10
    ----              180,00
     1058             ------
      973             118 ,00
    ----    angle C, required
      857
      534
    ----
      231
      139
    ----
      929
      834
    ----
       25
```

```
4977 : 139 :: 5198
                139
               -----
               46782
              15594
              5198
             -------
4977)722522(145.2 or equal
     4977     ſide B C,
     ----     required
     22482
     19908
     -----
     25742
     24885
     -----
      8576
```

Caſe 3d, In the oblique angled plain triangle A B C is given the angle B 29.51, and the containing ſides A B equal 244,7, and the ſide B C equal 145,2, to find the other angles and ſide A C.

The

The Geometrical Conſtruction. Pl. 2. Fig. 118

Make the ſide A B equal 244,7, and aagle ▲ 29 ,51, and draw the line A C, which make equal 145,2 from any ſcale of equal parts, and laſtly join the points B and C, and it is done.

Menſuration Mechanical,

The angles C and B meaſured on the line of chords are 31 ,19, and 118 ,50, and the ſide A C meaſured on the ſame ſcale of equal parts you took A B and A C from, gives the ſide A C equal 139 leagues, as was required.

SOLUTION Literal.

AB + ÆC = 244,7 + 145,2 = 389.6
AB — BC = 244,7 — 145,2 — 99.5

Half Z ∠	75 ,04
Half × ∠	43 ,49
Angle C	118 ,50
Angle A	31 19

		co, Ar,
As half Z ſides	389,9	7,409047
Is to × of ſides	99,5	1,997823
So is T. half Z ∠	75,04	10,573973
To T. half × ∠	43.46	9,980843
Again, As S ∠ A	31,19	0,284191
Is to ſide B C	145,2	2,161967
So is S. angle B	29,51	9,696995
To the ſide A C	139	2,143153

Inſtrumentally, by Scale and Compaſſes,

Extend the compaſſes from 389,9, the ſum of the ſides to 99,5 the difference of the ſides on the line of numbers, that extent applied the ſame way from tangent 73 ,07, half the ſum of the unknown angles, will give 23 ,34 on the line of tangents, the half difference of the angles.

Then extend from S. ∠ B 31 ,19 to S. ∠ A 29 ,51, that extent applied the ſame way from ſide B C 145,2, on the line of numbers will give 139 for the ſide A C required.

Arithmetically by of Natural Sines and Tangents.

Tangent 75 .04 equal 3,749, Then as the ſum of the ſides 389,9 is to the × of the ſides 99,5, ſo is 3,749 (N. Tan, half ſum of the angles unknown) to the tangent half × of angles.

That is $89,9 : 99,9 :: 3749 : \frac{3.749 \times 99,5}{3899} = ,9567$, equal N.T. 43 ,44 equal difference of angles.

Half Z angles	75 ,04
Half x angles	43 ,44
Angle C	118 ,48
Angle A	31 ,20

For the side A C, angle A 31 ,20
N. S. 5200 Angle B 26 ,51 N.S. 4979
Then 5200 : 145,2 : : 4997 $\frac{145,2 \times 4977}{52}$
equal 139 equal side A C required.

Axioms 4th. From the half sum of the three sides, subtract each side severally, but first that side opposite to the angle required, then the rest severally, noting their remainders.

Then as the product of the half sum of the sides and first remainder, is to the product of the other two remainders, so is the square of Radius, to the square of the Tangent of half the angle opposite to the first remainder.

Example 1st. In the oblique angled plain triangle A B C, is given the side A B, equal 244,7 miles side B C equal 145,2 miles, and the side AC equal 139 miles; I demand all the angles severally, of the said triangle.

The Geometrical Projection. Pl. 3, Fig, 103

Make A B equal 244,7 parts or miles, and from the same scale of equal parts, take 145,2 in your compasses, and with one foot in A, describe the arch, then with 139 in your compasses, and one foot in B, with the other cross the former arch in C. join A C and B C, and the triangle is made, Let fall the perpendicular C D, from the point C, which divides the oblique triangle into two right angled triangles, A D C and B D C. both right angled at D, make D E equal D A, so shall B E be the difference of the segments of the base.

The Logarithmetical Solution.

Side A B	244,7
Side B C	145,2
Side A C	139,0
Sum of sides	528,9
Half sum	264,45
Remainders	19 ,75
	119 ,25
	125 ,45

Half sum sides 264 ,45 co ar.		7,577739
1 Remainder 19 ,85 co. ar.		8,704433
other Remainders	119 .25 logar.	2.076276
	125 ,45	2,098297
		20,456745
Half is		10,228372

Tang. 75 ,25
2
118 ,50 equal angle C

For

For the angle A.		co. ar.
Half sum sides	264 ,45	7,577739
Rem.	119 ,25	7,923724
		logar.
Other Rem.	19 ,75	1,295567
	125 ,45	2,098297
Sum		10,895327
Tang.	15 ,40	9,447663
	2	
doubled is	31 ,20	equal angle A.

For the angle B.		co. ar.
half sum sides	264 ,45	7,577739
Op. Rem.	125 45	7,901703
		co. ar.
Other Rem.	119 ,25	2,076276
	19 ,75	2,295569
Sum		18,851287
Tang.	14 ,55	9,425642
	2	
doubled is	29,50	= ∠ B as required

Inſtrumentally by Scale and Compaſſes.

Extend the compaſſes from 145,2, the greater of the containing ſides, to 264,4, half the ſum of the ſides, that extent applied the ſame way from 19 ,75 the oppoſite remainder will give 35,8, a fourth number, then extend from 35,8 the fourth number to 139, the leſſer of the containing ſides, that extent applied from o on the verſed ſines, will give 118 ,50 the angle c required.

Again, Extend the compaſſes from 244,7, the greater of the containing ſides to 264,4, half the ſum of the ſides, that extent applied the ſame way from 119 ,25, the oppoſite remainder will give 128,1, a fourth number then extend from 128,1, the fourth number to 139 the leſſer of the containing ſides, that extent applied from o on the verſed ſines will give 31 ,20 for the angle A required,

Again, Extend the compaſſes from 244,7, the greater containing ſides to 264,4, half the ſum of the ſides, that extent applied the ſame way from 25 ,45, will give 134, a fourth number then extend from 134, the fourth number to 145,2, the leſſer of the containing ſides, that extent applied from o on the verſed ſines, will give 26 ,50 for the angle B required.

The Axiom is of excellent uſe to find an angle at one operation, yet not being ſo applicable to the inſtrumental way of working proportion, I here give the fourth axiom, in other terms, which finds an angle at two operations, and may be wrought both inſtrumentally and logarithmetically.

Axiom 4th. In other words when the three ſides of any plain triangle is given to find the angles.

As the longeſt ſide, is to the ſum of the two ſhorteſt ſides, ſo is the difference of the two ſhorteſt ſides, to the difference of the ſegments of longeſt ſide, made by a perpendicular let fall from the vertical angle upon the baſe or longeſt ſide.

Note, let fall the perpendiculur C D, (ſee the figure before-going) from the angle oppoſite to the longeſt ſide, which divides into two ſegments, and the obtuſe triangle into two right angled triangles.

A C	139,0
B C	145,2
Sum of ſides	284,2
Difference of ſides	6,2

Z. ſeg. 244.7
X ſeg. 7,2
Sum 251,9
Diff. 237,5

Gre. ſeg. 125,95
Leſſ. ſeg. 118,75

244,7 : 284,2 : : 6.2
6,2
5684
17052
244,7) 176204 (7.2
17129
4914
4894
: : 20

Menſuration Mechanical.

With a chord of 60 degrees, deſcribe arches from the angular points A B C, to cut the containing ſides of the ſaid angle, theſe arches reſpectively meaſured, will give the quantity of the angular, viz. angle A equal 31,20, angle B equal 29,50 an angle C 118,50 as was required.

Solution Logarithmetical.

As Hypoth. A C 139	2,143015	As Hypoth. B C	145,2
Is to Radius 90,00	10,000000	Is to Radius	90,00
So is baſe A B 118,75	2,074451	So is baſe B D	125.9
		To S. ∠ B C D	60,11
To S, ∠ ACD 50,39	9,931436	Subtract from	90,00
Hence angle A equal 31,21		Hence ∠ B equal	29,49

Otherwiſe, As ſide A C, : S. angle B, : : ſide A B, : S. ∠ C acute.
again, As A C 139, : ∠ B 22,50 : : ſide A B 2447, : S. 61,09.
Take this from 180,00, remains 118.51 equal angle C.

Inſtrumentally by Scale and Compaſſes.

Extend the compaſſes from the baſe A B 244,7, to the ſum of the ſides 284,2 on the line of num, that extent applied the ſame way from 6,2, their

their difference will give 7,2, the difference of the ſegments by adding and ſubtracting the ſaid difference to and from 244,7, and dividing the ſum and difference by 2 gives 125,95, and 118,75 for the ſegments of the baſe, then extend from the hypothenuſe A c 139, to the leſſer ſegment A D 118,75, that extent laid from S. 90,00 will give S. 58,39; and 90,00 — 58,39 = 31,21 for the angle A, then extend from 145,2 to 125,95 on the line of numbers, that extent laid from S. 90,00 gives 8. 60,11, which take from 90,00 gives S.29,49 the angle B.

The Uſe of Oblique angled Triangles in taking Heights and Diſtances, &c.

Problem I. To take an inacceſſible altitude from any two ſtations taken at pleaſure.

Suppoſe that there is a tower c D E F G H I, whoſe altitude c D you would know, and alſo how far it is off the ſtations A or B, taken at any convenient diſtance from each other. Firſt. ſtanding at B, take with your quadrant, or any other proper inſtrument, the angle D B c, which ſuppoſe equal 45,21.

2d. Meaſure 240 yards, or any other convenient diſtance from B to A, leaving B in a right line between yourſelf and the center of the tower C D. Pl. 3d. Fig. 121

Being at A, direct your inſtrument again to c, and find the quantity of the angle B A c, which ſuppoſe 31,11, then take this out of the angle B equal 45,21, and there will remain the ∠ c 14,10.

To find how far it is from the Station at A *to the top of the Tower at* c, *or length of the viſual ray* A c. ſay,

		co. ar.
As S. ∠ c	14,10	0,611289
Is to diſt. A B	240	2,380211
So is S. ∠ B	45,2	19,852122
To ſide A c	697.6	2,843622

To find the hight of the Tower at D C,

As Radius	90 00	10,
Is to hyp, B c	507,6	2,705544
So is angle B	45,21	9,882122
To the height C D	451,S	2,557666

For the length of the viſual ray B c

		co. ar.
As ∠ c	14,11	0,611289
Is to ſide A B	240	2,380211
So is S, angle A	31, 11	9,714144
To ſide B c	507,6	2,705544

To find how far the Tower at D, is from the firſt ſtation at B,

As Radius	90,00	So,
Is to hyp, B c	507,6	2,705543
So is S, ∠ B	44,39	9,846766
To ſide B D	356,7	2,552360

To B D 356,7 + 290 = 596,7 A B

Problem

PROBLEM II,

To find the Height of an Object ſtanding upon a Hill, or of a Spire ſtanding upon a Tower.

Suppoſe O A B C, to be a ſpire ſtanding upon the tower A B C D E F, whoſe height you would know, and alſo that of the ſpire.

Upon paper or the like, draw a right line of any length, as B Q, and therein aſſume any point at pleaſure at M, for your firſt ſtation, then directing your inſtrument to the top of the ſpire at O, you will have the angle O M *n* 56 ,15, and when you direct it with the baſe at R, you have the ∠ R M F 37 ,16, having found theſe two angles, then protract them from M by the lines M *e* and M *f*, drawn out from M at pleaſure.

2d. Go from M any convenient diſtance, ſuppoſe 169 yards to W, and then directing your inſtrument to O, you will have the angle O W F 37 , 30, and then directed to the baſe at R, gives the angle R W 20 ,56, then upon the point W, protract theſe two angles, and draw the lines W S and W R, until they cut the lines M *f* and M *e*, in the points O and R, from which points let fall the lines O *n* and R E, perpendicular to P Q, the firſt of which is the height of the ſpire and tower together, and the other the height of the tower, whence the height of the ſpire may be found by the ſame line of equal parts, by which you laid down M W.

3d, By the interſection of theſe lines, you have two oblique angled plain triangles W O M and W R M, and two right angled triangles M R E and M O *n*.

4th, In the oblique angled triangle W O M, we have the ſide W M, 169 yards, the angle M W O 37 30 and the external angle O M N 56 ,15, from which take 37 ,30 and there remains the angle W O M 19 05 equal angle W O M, by theſe find the line M O. as follows,

		co, ar,
As S, ∠ W O M	19 ,05	0,485528
Is to ſide W M	196	2,292256
So is S, ∠ M W O	37 ,30	9,784447
To ſide M O	365	2,562231

As Radius	90 ,00	So,
Is to ſide M O	365	2,562231
So is S, ∠ O M N	56 ,15	9,916846
To Per. O N	30 ,35	2,482127
The height of the Tower and ſpire		

This line M O, is the hypothenuſe of the right angled triangle M O N, from which and the angle O M N 56 15, we find *o n*.

2d, In the oblique angled triangle W R M, we have the ſide W M 196, the angle M N R 20 ,56, and external angle R M E equal 37 ,10

37 ,10, from which take M W R 20 ,56, and there will remain the angle W R M equal 16 ,14.

	co.	ar.
As S. ∠ W R M 16 .14	0,553541	
Is to ſide W R 196	2,292256	
So is S. ∠ R W M 26 ,56	9,553010	
To ſide R M. 250,5	2,398807	

This fine M R, is the hypothenuſe of the right angled triangle R M E, beſides which you have the angle R M E equal 37 ,10 to find R F,

Hence the towers height is 151,3, which take from O N equal 303,5, remains 153,2 the height of the ſpire required.

As Radius 90 ,00	10,	
Is to hyp. E M 250,5	2,398807	
So is S. ∠ R M E 37 ,10	9,781184	
To ſide R F. 151,3	2,179941	

PROBLEM III,

To take an inacceſſible Diſtance at two Stations.

Being near a river, I ſee a church on the other ſide, whoſe diſtance from any two ſtations A and B, taken at pleaſue I would know.

1ſt. Set up two marks, A and C, and meaſure their diſtance, which let be 320 yards.

2d, Planting your theodelite. or any other convenient inſtrument, at C, take the angle E C A, which ſuppoſe 118 ,55, whoſe ſupplement is 61 ,05 equal E C D.

3d, Go to A, and ſet up your inſtrument and take the angle EAC, ſuppoſing it to be equal 42 ,00, then having protracted your obſervations, you will form an oblique angled triangle, ſuch as A E C, in which there is given the ſide A C 320, and if you take the angle E A C 42 ,00, out of the angle E C D, there will remain 19 05 equal angle C E A.

4th To find the diſt. of the church from the ſtation at A.	Co,	Ar,
As S. ∠ C E A 19,05	c,4855279	
Is to ſide C A 320	2,5051500	
So is S, ∠ E C D 61,05	9.9921688	
To ſide E A 857 yrds	6,9328467	

To find the diſtance of the church from the ſtation at C.	Co,	ar,
As S. ∠ C E A 19 ,05	0,4855279	
Is to ſide C A 320	2,5051500	
So is S. ∠ E A C 42, 00	9,8255109	
To ſide E C 655 yds.	2.8161888	

Anſwer, The church is diſtance from ſtation at C, 655 yards, and from ſtation at A 857 yards, as required.

PROBLEM IV.

To find the Diſtance of two or more places, from the Stations whence you obſerved them, and alſo how far they are off one another.

Being deſired to find how far the wind mill at F, is from the houſe at E, and how far either of them is from the ſtations A and C, taken at pleaſure.

1ſt, Set up two marks at the ſtations A and C, and meaſure their diſtance, which let be 320 yards.

2d. Place your inſtrument at A. and take the angle F A C which we ſuppoſe equal 102 ,20, and alſo the angle C A E equal 42 ,00.

3d, Remove your inſtrument to C, and there take the angle F C A, equal 41 ,56 and E C A equal 118 15.

4th, Having protracted, or laid down your obſervations upon paper you will form two oblique angled triangles, viz. E A C, and FAC.

5th. Take the angle E A C equal 102 ,20 out of 180 00, there will remain the external angle F A B 77 ,40, from which take the angle F C A 41 .56, and their will remain the angle A F C 35 ,44. which being found, Then

6. To find how far the wind-mill is from the firſt ſtation at A.		Co, ar,	7. To find how far the wind-mill is from the ſtation at C.		Co, ar,
As S. ∠ AFC	35 ,44	0,233577	As S. ∠ A F C	35 ,44	0,233577
Is to diſt. of ſta.	320	2,505150	Is to diſt. of ſta.	320	2,505150
So is S. ∠ F C A	41 ,56	9,824949	So is ſext. ∠ F C A	77 ,40	9,989059
To ſide A B	366	2,563676	To S. E C	535	2,728586

8, Take the angle E C A equal 118 55, out of 180 ,00, and there will remain the external angle E C D, of the oblique angled triangle A E C 61 ,05, out of which take the angle E A C equal 42 ,09, and on it there will remain the angle A E C equal 19 ,05.

9, To find the diſt. of the houſe from the firſt ſtation A,		Co, ar,	10. To find the diſt. of the houſe from the ſecond ſtation at C.		Co, ar,
As S, ∠ A F C	19 ,05	0.485527	As S, ∠ A E C	19 ,05	0.485527
Is to diſt. of ſta.	320	2,505150	Is to diſt. of ſta.	320	2.505150
So is S, ∠ E C D	61 ,05	9,942198	So is S. ∠ A C	42 .00	9,825511
To ſide A E	857	2,932845	To ſide E C	655	2,816188

To

11. To find how far the wind-mill is from the houſe or the length of the line E F, you have in the oblique angled triange F A E, the ſide F A equal 366, (found at article 6th.) the ſide A E equal 857 (found at article 9th) and if from the angle F A C equal 102 ,20 you take C A E equal 42 ,00 (See art. 2d.) there will remain the included angle F A E equal 60 ,20, this taken out of 180,00, and there will remain 119.40, the ſum of the angles F and E, the half of which is 59 ,50, now according to caſe 4th of oblique angled triangles ſay,

		Co, ar,
As the ſum of the including ſides A E + A F	1223	6,912574
Is to the difference A E — A F	491	2,691054
So is T. half ſum of the angles	59 ,50	10.235642
To tangent of an arch	34 ,38	9,839303

The difference between this and the half ſum is 25 ,12 equal to the angle F E A. Again ſay,

		Co, ar,
As S. angle F E A	25 ,12	0,370815
Is to ſide A F	366	2.563481
So is S. angle F A E	60 20	9,938979
To diſtance F E	747	2,873275

PROBLEM V.

Let there be a Houſe upon a Hill a S, *to be ſupplied with water from a Spring at* O, *in a Valley, between this Hill and the Hill at* R, *and let it be required to find how high the Water muſt be raiſed to come to the ſaid Houſe.*

Here it is ſuppoſed that there are not to be found in this valley, two places upon a level, from whence obſervations can be made (as at Prob. I.) therefore we muſt take ſome other way to anſwer what is propoſed.

Firſt, Make choice of any convenient point P, upon the ſide of the hill B, from whence you may ſee the houſe, and alſo the ſpring; then by help of Siſſon's theodolite, or ony ſuch inſtrument for leveling, find the height of *p n*, above the level of the ſpring at O, and the angle *p o n*, by theſe find *p o*, (by caſe 2d, of right angled triangles) and this line is one ſide of the oblique angled triangle *p ſ o*.

2d. Your inſtrument being at O, direct the ſight to *t*, and take the angle to 1, whoſe complement to 90 ,00 is the angle *ſ o t*, equal angle *t ſ o*, to which add the complement of the angle P *o n*, and the

ſum will be the angle *p o ſ*, one angle of the ſaid oblique angled triangle

3d. When at *p*, take the angle *c p ſ*, which add to *p o n*, equal *c p o*, (*c p* being an horizontal line) the ſum of theſe two is the angle *ſ p o*, which add to the angle *p o ſ*, and the ſupplement of that ſum to 180,00, is the angle *p o ſ*, by which and what alſo is given in the triangle *ſ p o*, find the ſide *ſ o*, and this is the hypothenuſe of the right angled triangle *t ſ o*, with which and the angle *t o ſ*, before found, you may find the perpendicular height the water is to be raiſed as was required.

PROBLEM. VI.

There is a rock near the Peak in Derbyſhire, riſing to a wonderful height, which is inacceſſible, I endeavoured to meaſure in a mathematical method from a ſtation at ſome diſtance, (nearly level with the rock) I took an angle of altitude to its top equal 47 ,30 and having deſigned a ſecond ſecond ſtation, I took an horizontal angle of 87 ,05 between the foot of the rock and that ſtation, the meaſured diſtance between the ſtations was four chains and twenty-nine links, or 429 links (per Gunter) at that place I had an angle of altitude equal 41 ,12, but forgot from hence to take an angle between my firſt ſtation and the foot of the rock, yet am in hopes ſome curious artiſt, will from this data, determine the perpendicular height of this ſtupendious rock.

This problem was propoſed by Mr. Henry Travis, at page 21, of the Ladies Diary, for 1740, and anſwered by the ſame ingenious perſon, at page 6 and 7, of the Ladies Diary for 1141; but ſuppoſing many of my readers (for whoſe ſake this whole work is compoſed) have not yet arrived to the knowledge of algebra, I have given them the meathod of anſwering the queſtion by ſing e poſition as followeth.

Having drawn A B, to repreſent the rock, ſuppoſing its height A B, to be 50 links, C the firſt ſtation and B C its diſtance from the foot of the rock at B, and making a right angle at B, with the height A B.

Let D, be the ſecond ſtation, and its diſtance from the foot of the rock equal B D, making a right angle at B, with the line A B, and B C the diſtabce of the two ſtations equal 429 links. Then

Firſt, By help of the angle A C B equal 47 30, and ſuppoſed height of the rock equal 50 links, find the ſuppoſed diſtance of the firſt ſta- B C, as followeth.

As 1. angle A C B	47 ,30	co. ar.	0.132369
Is to ſuppoſed height A B	50		1.698970
So is co. S.	47 ,30		9,829683
To ſuppoſed diſt. of the firſt ſtation B C	45 ,81		1,660122

2d.

2d. With the angle A D B 41 ,12, and ſuppoſed height A B 50, findthe diſtance of the ſecond ſtation from the foot of the rock (viz.) B D ſaying,

As S. angle A B D	41 ,12	co. ar.	0.181319
Is to ſuppoſed height A B	50		1,698970
So is C S.	41 ,21		9,876457
To B D	57 ,11		1,756746

3d. Now in the oblique angled triangle D c B, you have the ſuppoſed length of the ſide B C equal 45 ,81, and B D equal 57 ,11, with the horizontal angle B C D equal 87 ,05, to find the angle B D C, and this will be the quantity of the horizontal angle which was forgotten to be taken between the firſt ſtation and foot of the rock. ſaying,

As ſuppoſed ſide C B	57 ,11	co. ar.	8,243253
Is to S, angle B C D	87 05		9,999470
So is ſuppoſed ſide B C	45 ,81		1,660960
To S. angle B D C	53 ,14		9,308650

And this is the horizontal angle, which was forgot to be taken between the foot of the rock and the firſt ſtation, as before ſaid.

4th. Having found the angle B D C equal 53 ,14, addd it to the horizontal angle B D C equal 87 ,05, and the ſum is 140 ,19, whoſe ſupplement is 39 ,41 equal angle D B C, ſo now you have the ſuppoſed ſide B C 45 ,81. and the angle B D C equal 53 ,14, and the angle D B C equal 39 ,41, to find the ſuppoſed length of the ſide D C, to which ſay,

As S, angle B D C	53 ,14	co. ar.	0,090324
Is to ſide B C	45 ,81		1,660960
So is S, angle D B C	39 ,41		9,805190
To ſide D C	36 ,52		1,562474

Hence the ſuppoſed diſtance of the two ſtations 36 ,52

But the true diſtance was 429 links, therefore, as the ſuppoſed diſtance is found to be two little ſo muſt the height of the rock be, then ſay,

As the ſuppoſed diſtance	36 ,52	co. ar.	8,437469
Is to the true diſtance	429		2,632457
So is the ſuppoſed height	50		1.698970
To the true height of the rock	587.4 links		2,768896

Hence the height of the rock is 5 chains 874 links, as was required.

The

The Doctrine of oblique Triangles, applied to a great variety of curious, uſeful, and entertaining Problems in Navigation.

Queſtion 1ſt. Suppoſe two ports lie north and ſouth of each other, and ſhip ſails from the northermoſt S. E. by E. 147 miles the ſouthermoſt ſhip ſails N. E. half E. till ſhe meets the firſt ſhip; I demand the diſtance of thſe two ports and the ſecond ſhip diſtance run.

Angle B equal fives points	56,15
Angle A, equal four points and a half	50,37
Their Sum	106,52
Subtract from	180,00
Remains angle C	73,08

The Geometrical Conſtruction. Pl. 3. Fig. 127

Draw the north and ſouth line A B, at pleaſure, and make the angle A B C equal five points or 56,15 and make B C equal 147 miles, from any ſcale of equal parts, and upon C. make the angle B C A equal 72,08 by drawing the S. W. half W. line A C, to cut the north and ſouth line A B in A, and the triangle is made,

Then in the triangle A B C, here deſcribed, let B repreſent the northermoſt A, the ſouthermoſt port B C, the northermoſt ſhip's courſe and diſtance A C, the ſouthermoſt ſhip's courſe and diſtance C, the place where the ſhips meet; then A B and A C meaſured on the ſame ſcale B C was taken from will ſhew your deſire for A B will be equal 181 and A C equal 158,2 miles the anſwer required,

By Trigonometrical Calculation.

As S. angle C A B	50,37	co. ar.	0,111867
Is to ſide B C	147		2,167317
So is S. angle A B C	56,15		9,919846
To the ſide A C	188,1		2,199030
As S. angle C A B	50,37	co. ar.	0,111867
Is to ſide B C	147		2,167317
So is S. angle A C B	72,08		9,978537
To the ſide A B	181		2,257717

Anſwer, the diſtance of the two ports is 181 miles, and the ſecond ſhip's diſtance is 158,1 miles as was required.

Arith-

Arithmetically by Natural Sines.

N. S. 50 ,37 equal ,7726
N. S. 56 ,15 equal ,8315
N. S. 72 ,05 equal ,9518

.7729 : 147 : : ,8315
147

58205
32260
8315

.7729)122,2305(158 ,14= miles
7729 A C.

44940
38645

62955
61832

11230
7729

35010
30916

.7729 : 147 : : .9518
147

66626
38072
9518

7729)139,9146(181,02=
7729 miles A B.

62624
61832

7926
7729

19700
15458

Here the anſwer is the ſame as before.

We ſhall hereafter only ſtate the proportions by natural ſines and tangents, &c, and leave the operation for the readers practice.

Queſtion 2d. Suppoſe two ports lies N. E. and S. W. of each other, and a ſhip ſails from the ſouthermoſt S. E. by S. three quarters E, 218 miles, another from the northermoſt runs 332 miles, and then meets the firſt, be pleaſed to find the courſe ſteered by the laſt, and the diſtance of the ports.

Geometrical Conſtruction. Pl. III. *Fig.* 128.

Draw the N. E. and S. W. line A B at pleaſure, then from the point A, make the angle B A c, equal 8 points and one quarter, or 92 ,27, by drawing the S. E. by E, three quarters E line, which make equal 218 miles, from your ſcale of equal parts, then from the ſcale take 332, in your compaſſes, and one foot in c, with the other cut the N. E. line in B, and draw the line A B, and B c, and the triangle is made.

Then in the triangle A B c, let A repreſent the ſouthermoſt, B the northermoſt port, A c the firſt ſhip's courſe and diſtance, and B c the ſecond ſhip's courſe and diſtance, c the place where the ſhips meet, then

then in this triangle here are two sides and an angle opposite, given to find the other angles and the third side.

Trigonometrical Calculation.

		co. ar,
As side B C	332	7,477862
Is to S. ∠ A	92,46	9,999475
So is side A C	218	2,338456
To S. ∠ B	40,59	9,815763

10,00—92,49—40,59=46,12

		co. ar.
As S. ∠B	40,56	0,183209
Is to side A C	218	2,338456
So is S. ∠ C	46,12	9,858373
To side A C	239,9	2,389036

From	45,00
Subtract	40,59
Remains	4,09

The northermost ship's course is S. 4,01 westerly.
Hence the dist. of the ports is 2399 miles, the answer required.

Arithmetically by Natural Sines.

	180,00
Angle A	92,49
Angle B	40,59
Remains	133,48
Angle C	46,12 = ∠ c.

Natural Sine 87 = 9988 Then

$$332 : ,9988 :: 218 : \frac{9988 \times 218}{332}$$

equal 6558 equal N. S. 40,59 equal angle B.

Angle C 46,12 N. S. = 7217

S. angle B : AC : : C : AB That is, 6558 : 218 : : 7217

Then $\frac{,7217 \times 218}{,6558} = 239,9$ = distance of the ports, the same as before.

Question 3d. Suppose two ships sail from one port, one sails S. W. by S. half W. 279 miles, the other sails S. E. by E. half E, 191 miles; I demand their bearing and distance asunder.

Geometrical Construction. Pl. 3d. Fig. 129

With the chord of 60 degrees, describe an arch of a circle sufficient to contain the sum of both courses, and draw the S. W, by S. half W. line A B which make equal 279 miles, and the S E. by E. half E, line, which make equal 191 miles, and draw the line B C, and the figure is projected.

In

Three and a half points	39 ,22
Five and a half points	61 ,52
Sum	101 ,14
Subtract from	180 ,00
Remains Z. angles	78 ,46
Half sum of the angles	39 ,23

In the triangle A B C, let A represent the port departed from, A B the first ship's course and distance, A C the second ship's course and distance, B C, the bearing and distance of the two ships, here are two sides, and the angle between them given, to find the other angle, and the third side.

Side A B	279
Side A C	191
Z. of sides	470
Difference of sides	88

Half sum	39 .23
Half difference	8 ,44
Angle C	48 ,07
Angle B	30 ,39

As sum sides	470	co. ar,	7,327902
Is to difference of sides	88		1,944433
So is T, half Z angle	39 ,23		9,914302
To T. half × angle	8,44		9,186697

For the side B C, their distance asunder.

As S, angle B	30 ,39	co. ar.	0,292601
Is to side A C	191		2,281033
is S. angle A	101 ,14 (79 ,46)		9,805190
To side B C	367,8		1,562474

To three points and a half	39 ,22
Add angle B	30 ,39
The sum is	70 ,01

Hence the bearing of the ships is N. 70 ,01 easterly, or S, 70 ,01 westerly, and their distance asunder 367,8 miles, Q. E. I.

Arithmetically by Natural Sines and Tangent.

N, S. 39 ,23 equal 821	Z sides : × sides T. half Z ∠ : : T. half × ∠'s
N, S, 30 ,39 equal 5097	470 : 88 : : .821 $\frac{88 \times 821}{420}$, = ,1537
N, S, 78 ,46 equal 9808	equal N. T. 8.44

Half Z. angle	39 .23
Half × angle	8 ,44
Angle A	48 ,07
Angle C	30 ,39

5097 : ,191 : : ,9808

$\frac{9808 \times 191}{,5097}$ = 367,5 =

B C, the same as before.

Queſtion 4th, Suppoſe a ſhip ſails N, E, 150 leagues, then ſouth eaſterly 225 leagues, and then forced back by foul weather 315 leagues, to the place from whence ſhe firſt ſailed; I demand her ſecond courſe, and laſt courſe back?

In the oblique angled plain triangle A B C repreſent the place ſailed from at firſt, B the ſecond place, C the third place, B C the ſecond courſe and diſtance, and A C the third courſe and diſtance here are three ſides of a plain triangle given, to find the angles ſeverally.

The Geometrical Conſtruction. Pl. 3. Fig. 130

Draw the N. E. line A B, which make 150 from any ſcale of equal parts, then from the ſame ſcale of equal parts, take 225 ledgues in your compaſſes, placing one foot in B, deſcribe an arch, then with 315 in your compaſſes and one foot in A deſcribe an arch to cut the former arch in C, and draw the line A C and B C and the triangle is made.

Side A B	150	To find C E, the difference of the ſegments of the baſe or longeſt ſide A C,	
Side B C	255		
Z. ſides	405	315 : 405 :: 105 :	
X ſides	105	105	
		2025	
Hence A D	90	205	
C D	225		
		315)42525(235	

A C	equal	315
C E	equal	135
		450 | 225
		180 | 90

Here difference of the ſegments 135, which added to the ſum is 450, half of which is 225 the greater ſegment, and ſubtracted is 180, half thereof is 90, the leſſer ſegment of the baſe.

As hyp. A B	150	2,176091		As hyp. B C	255	2,406540	
Is to Radius	90,00	10,000000		Is to Radius	90,00	10,000000	
So is baſe A D	90	1,954242		So is baſe C D	225	2,352102	
To S. ∠ A B D	36,53	9,778151		To S. ∠ C B D	61,55	9,945642	

From	90,00	From	180,00	From	90,00	From	81,53
Subtract	36,53	Sub.	98,07	Subt.	61,54	Subt.	28,06
Rem.	53,73	Rem.	81,53	∠ C	28,06		53,47
Add	45,00						
Sum	98,07						

Hence her bearing from where ſhe departed when at C was N. 81,53 weſterly, and her ſecond courſe from B to C is S. 53,47 eaſterly as required.

Queſtion

Queſtion 5th. I being at ſea and bound to an iſland, and knowing neither the courſe, diſtance, × of latitude, nor departure, but I heard the maſter tell the mate, that if we ſailed N. W. by N. 92 leagues, then the iſland would bear ſouth and we would be 180 leagues diſtant from it; I deſire to know the courſe and diſtance from the iſland at firſt ſetting out,

Geometrical Conſtruction. *Pl.* III. *Fig.* 131.

Draw the N. W. by N. line A B equal 92 leagues, then the ſouth line B C equal 180 leagues from B, and join A C, and the figure is projected; for A B repreſents the firſt courſe and diſtance, ordered by the maſter, B C her diſtance then due north from the iſland, and A C her diſtance at firſt from the iſland.

By Trigonometrical Calculation.

Side B C 180	From	180 ,00			co. ar.
Side A C 92	Subt.	33 ,40	As ſum ſides	272	7,535431
			Is to × of ſides	88	1,944483
Sum 272	Z ∠	146 ,40	So is T. half Z. ∠	73,07	10,517833
× ſides 88	Remains	73 ,07	To T. half × ∠	46,50	10,027747

Half Z. of angle	73 ,07				co. ar.
Half × of angle	46 ,57	As S. angle C		26 ,17	0,353782
		Is to ſide B A		92	1,963788
Angle A	119 ,57	So is S. angle B		33 ,45	9,744739
Angle C	26 ,17	To the ſide A C		115,4	2,062309

Anſwer, Her courſe to the iſland is S. 26 ,17 weſterly, diſtance 115,4 leagues.

Queſtion 6th, Suppoſe a merchant's ſhip in latitude 45 ,30 N. falls into the hands of pirates, who takes away his ſea compaſs, after which he ſails as directly as he can 67 leagues in the S. W. quarter, and at the end of two days met with a man of war, who alſo had been the day before in the latitude 45 ,30 N, and had ſailed thence S. E. by S. 39 leagues, now the merchant ſhip left thoſe pirates lying to an fro, where they robbed him, and the man of war being deſirous to ſpeak with thoſe pirates; required what courſe he muſt fteer to come up with them?

Geometrical Conſtruction. Pl. 3d. Fig. 132

This preſents us with an oblique angled plain triangle, in which are two ſides and an angle oppoſite to one of them given, to find the other angles and the third ſide, which triangle is thus made.

1ſt.

1ſt. Deſcribe a circle with a chord of 60 degrees, and quarter it with two diameters, making N E W S, and A at the center, but always N at the upper part, and E at the right hand of the circle.

2d, Then lay three points from s towards E on the circle, and draw the S. E. by S. line A D equal 39 leagues.

3d. With 67 in your compaſſes, and one foot in D, cut the lines A E, produced in C, the place where the ſhip falls in with the pirates; then a line drawn from D to C, and it is done, for A and c, are both in latitude 45 ,30 north, and A D repreſents the man of war's courſe and diſtance, c D the merchant man's courſe and diſtance, after he loſt his compaſs, ſo that the angle A C D being meaſured on the ſcale of chords will ſhew her courſe from the weſt towards the ſouth, the oppoſite point is the man of war's courſe northerly, to find thoſe pirates as was required.

Trigonometrical Calculation.

				Co, ar,
From 90 ,00	From 90 ,00	As ſide D C	67	8,173925
Su. ∠C 28,57	Subt. 33 ,45	To S. angle c	56 ,15	9,919846
		So is ſide A D	39	1,591065
Rem. 61 ,23	Rem, 56 ,15			
		To S. angle c	28 ,57	9,684836

Anſwer, The man of war's courſe is N. 61 ,03 eaſterly, to meet with the pirates, as required.

Queſtion 7th. Coaſting along ſhore I ſaw two capes of land, the firſt did bear north, the ſecond bore W. N. W. from me, I ſtood away N. W, ba N. nine miles, until the firſt bid bear E. by S, and the other S. by E. the bearing and diſtance of them required?

Geometrical Conſtruction. *H°.* III. *Fig.* 133

In all queſtions of this kind, you muſt as preparative work, find the diſtance of each cape from the ſhip at firſt ſeeing them, or at laſt ſeeing them, which is evident by the projection thus,

Having drawn a circle and quartered it with the diameters, and placed the letters N s E W and A, at the center as directed in the laſt queſtion produce A N up higher, by reaſon the firſt bearing is north, then lay ſix points from N towards W, and draw the W N W line for the ſecond capes bearing.

2d. Lay three points from N towards W, and draw the N. W. by N. line equal nine miles from A to D, the ſhip's courſe and diſtance.

3d.

3d. Then lay one point from s towards E, and lay a ruler on it at A, and draw an E, by s. line from D, parallel to the rulers edge to cut the north line in B, the firſt cape.

4th, In like manner lay one point from s towards E, and draw the s, by E. line from D, parrallel to the edge of the ruler to cut the W, N, W, line in C, the ſecond cape.

5th, Draw a line from B to C, and it is done; for the line B C repreſents the bearing and diſtance of the two capes from each other, which being meaſured on the ſame ſcale A D was taken from, will ſhew their diſtance aſſunder, and the angle A B C meaſured on a ſcale of chords, will ſhew their bearing to be ſouth weſterly, and north eaſterly, as was required.

But to find theſe things by trigonometry, you may find the ſides A B and A C, or otherwiſe the ſides D B and D C, which is done in the oblique triangle A B D and A C B, in each of which, all the angles and one ſide are given to find a ſide. And note, A repreſents the ſhip at firſt ſeeing them, and D the place at laſt ſetting them, ſo that when the ſides A B and A C, or D B and B C, are found, then is there either in the oblique triangle A B C or D B C to work in, B C is the ſide common to both triangles with its agreeing angles may be found, by which their bearing and diſtance from each other is diſcovered, and in each triangle there is two ſides, and an angle between them given, to find the other angles and the third ſide which is done by the calculation following.

Trigonometrical Calculation.

1ſt. In the oblique triangle A B D, all the angles and ſide A D, is given, to find ſide A B, viz. angle D B A equal nine points, equal 101 ,15, angle B A B equal three points or 33 ,45, angle B D A equal four points or 45 ,00, and the tide A D equal nine miles.

2d. In the oblique triangle A C D, all the angles and ſide D A, are given to find the ſide A C, viz. C A D equal three points or 33 45, angle C D A equal two poinrs or 22 ,30, angle A C D equal eleven points or 123 ,45 with the ſide A B.

As *S.* angle D B A	101 ,15 (78 ,45)	co. ar.	0,008427
Is to ſide D A equal	9		0,954242
So is S. angle B D A	45 ,00		9,849585
To the ſide B A	6,49		0,812154

As

As S. angle C	123 ,45 (56 ,13)	co, ar,	0,050154
Is to ſide A D	9		0,954242
So is S. angle D	22 ,20		9,582839
To the ſide C A	4,142		0,617231

Laſtly, in the oblique triangle A B C, is two ſides, and an angle between them is given, to find the other angles and the third ſide viz. A D equal 6,49 miles, ſide A C equal 4,142 and B A C equal ſix points or 67 ,30 to find the other angles and the third ſide B C.

Side A B	6,49	From	180 ,00	Half ſum angles	56 ,15
Side A C	4.142	Subtract	67 ,30	Half × of angles	18 ,18
Sum	10,632	Z. angle	112 ,30	Angle A C B	74 ,33
× ſides	2,348	Half ſum	56 ,15	Angle A B C	37 ,57

As the ſum of the ſides	10,632	co, ar.	1,026533
Is to the difference of ſides	2,348		0,370695
So is T. half ſum of the angles	56 ,15		10.175107
To T. of half × of angles	18 ,18		9,519268

The Proportion to find the ſide B C.

As S. angle A B C	27 ,57	co, ar,	0,211144
Is to ſide A C	4,142		0,617235
So is S. angle B A C	67 ,30		9,965615
To ſide B C	6,223		0,793994

Anſwer, Courſe S. 37 ,57 weſterly or S, W. by s, half W. nearly, and their diſtance 6,223 miles, as was required,

Queſtion 8th. Suppoſe a ſhip ſails N. W. two iſlands appear in ſight, one bears W. N. W. the other N, from the ſhip, and when the ſhip had ſailed ſix miles further, the firſt bore W. by S, and the other N. E, Required to find their bearing and diſtance?

The Geometrical Conſtruction.

Draw a circle with the cord of 60, and quarter it with two diameters, placing N s W E, as directed in the laſt queſtion, putting A in the center, and producing A N up higher, draw a N. W. line, which make equal ſix miles, then lay ſeven points from s towards W, and by it and A,

A, draw a W. by S. line, parallel to the rules edge from D, to cut the W. N. W. line in C, the firſt iſland.

2d. Lay four points from N. towards E, and lay a ruler from that to A, and draw a N. E. line parallel to the rulers edge from D, to cut the north line produced in B, the other head land, and draw the line B C and it is done.

The Geometrical Conſtruction.

1ſt. In the oblique angled plain triangle A D C, all the ∠s and ſide A D are given to find the ſides A C or D C, viz. angle D A C equal two points or 22,30, the angle A D C equal eleven points 123,45, the ∠ A C D equal three points or 33,45, and the ſide A D equal ſix miles, to find the other ſides as above.

As s. angle A C D	33,45	co. ar.	0,255261
Is to ſide A D	6 miles		0,778151
So is S. angle A D C	56,15		9,919846
To the ſide A C	8,95		0,953258
As s. angle A C D	33,45	co. ar.	0,255361
Is to ſide A D	6		0,778151
So is s. angle D A C	22,50		9,582840
To the ſide D C	4,14		0,616252

2dly. In the triangle A B D is all the angles and one ſide given, to find the ſides A B or B D, viz. angle D A B equal four points or 45,00, D B A equal four points 45,00 angle A D B equal eight points 90,00, and ſide D A equal 8 miles.

As s. angle D A C	45,00	9,849485
Is to ſide A D	6	0,778151
So is Radius	90,00	10,
To the ſide A B	8,485	9,928606

Since equal ſides ſubtends equal angles the ſides AD and DB are equal.

Laſtly, In the oblique angled plain triangle C D B, there are two ſides, and an angle between them given, to find the other angles, and third ſide, viz. ſide CD 4 14 ſide DB 6 and ∠ C D B equal 146 15, to find the reſt.

Side D B	6	From	180,00	Half Z. ∠	16,52
Side D C	4 14	Subt.	146,15	Half × ∠'s	3,03
Sum ſides	10 14	Sum	33,45	∠ B C D	19,55
× ſides	1 86	Half Z.	16,52	∠ D B C	13,49

As ſum of ſides	10,14	co. ar.	8,993962
Is to difference of ſides	1,86		0,269513
So is T. half of ſum ∠	16,52		9,462615
To T, half difference of angles	3,08		8,726090

To	45,00	As S. angle D c B	19,55	co, ar, 0.437687
Add	13,49	Is to ſide D B	6	0,778151
Sum	58,49	So is S, angle c D B	33.45	9,744739
		To ſide c B	9,785	5.990577

Anſwer, Their bearing is S, 58,49 weſterly, or N, 58,49 eaſterly, diſtance 9,785 miles, as was required.

Queſtion 9th, Suppoſe three ſhips ſails from one port, the firſt ſails S, W, by W, the ſecond W, by S. half W, and the third S, by Weſt, 8 miles, then the firſt bears from the third S, by W, and the ſecond bears from the third S, S, E.; I demand the firſt and ſecond ſhips diſt, ſailed, and their bearing and diſtance from each other,

The Geometrical Conſtruction.

Having drawn a circle with the chord of 60, and quartered it with two diameters, placing N, S, E, W, as before directed, then lay three points from S towards W, and draw the S, W, by W, line at pleaſure, again lay 7 points and a half from S towards W, and draw the W, by S. half W, line at pleaſure, after the ſame manner draw the N, W. by W, line eight miles long; then lay one point from S towards W, and by it and A, draw the S, by W, line from D, parallel to the rulers edge, to cut the S, W, by W, line A c in c, the place of the firſt ſhip at that time, in like manner lay two points from *S* towards E, and by it and A, draw a *S*, *S*, W, line from D, parrallel to the rulers edge, to cut the W, by *S*, half W. line in B, the place of the ſecond ſhip, then draw the line D B and c B and it is done, for all the lines may be meaſured from the ſcale A D was taken from, and all the angles of the line of chords.

Trigonometrical Calculation. Pl. III, Fig, 135

1ſt. In the oblibue angled triangle D B A, all the angles, one ſide are given to find either of the other ſides, viz. angle D B A equal nine points, or 106,53, angle BAD, equal three proints and a half or 39,22, angle BDA equol three points or 33.45, and AD 8 miles.

		co, ar,			co, ar,
As *S*, ∠ DBA	73,07	9,999834	As *S*, angle AD	53,35	0,255261
Is to ſide A D	8	0,903090	Is to ſide A B	6	0,666963
So is S. ∠ ADB	33,45	9,744739	So is *S*, angle A	39,22	9,802282
To ſide A B	4,64	0,666993	To ſide B D	53	0,924506

2d,

2dly, In the triangle A D C all the angles and side D C, are given to find the other side, viz. angle D A C six points, or 67 ,30, angle A D C six points or 67 ,30, angle A C D four points or 45 ,00 and A D eight miles.

To find the side A C, or C D.

As s. angle A C D	45 ,00	co. ar.	0,150515
Is to side A D	8 miles		0,903090
So is S. angle A D C	67 ,30		9,965615
To the side A C	10 ,95		1,019220

Laſtly, In the oblique angled triangle A C D, are given two ſides and an angle between them to find the other angles and the third ſide, viz. A C equal 10,45, ſide A B 4,64, and angle C A B equal two points and a half or 28 ,07, to find the ſide C B and the other angles.

Side	A C 10.45	From	180 ,00	Half Z, angle	75.56
Side	A B 4,64	Sub.	28 ,07	Half × of angles	56 ,57
Sum	ſide 15 ,09	Z, ſum	151 ,53	Angle B	132 ,53
×	ſides 5 ,81	Half Z, ∠'s	75 ,56	Angle C equal	15 56

		co. ar.			co. ar.
As ſum ſides	15 ,09	8,821311	As s. an. B C A	18,59	0.487725
Is to × ſides	5,81	0,764176	Is to ſide B A	4,65	0.666963
So is T. ha. Z. an.	75,56	10,001081	So is s. an. B A C	28,07	9,673268
To half × an.	56 .57	10,186568	To ſide B C	7,6	6,827956

Anſwer, The firſt ſhip's diſtance is 10, 46 miles, the 2d. ſhip's diſtance is 4,64 miles, their bearing is N, 37 ,16 eaſterly, or ſouth 37 ,16 weſterly, or N. E. by N. half E, or S, W, by S, half W. as was required.

Queſtion 10th, Admit ſailing along ſhore, I ſee two head lands, the eaſtermoſt bears N, N. E, the weſtermoſt N. W. from me at the ſame time an iſland bears ſouth, then after I had ſailed weſt eight miles, the firſt did bear N E. by E. half E. the ſecond N. N. E. and the iſland E. S. E. from me, the bearing and diſtance of theſe places from each other are ſeverally required.

The Geometrical Conſtruction.

Draw a circle with the chord of ſixty degrees, and quarter it with two diameters, placing the letters N E W S at the ſeveral quarters. then lay two points from N towards E, and draw the N. N. E. line at pleaſure for the bearing of the eaſtermoſt headland.

2dly. Lay from N. towards W. and draw the N. W. line at pleaſure, for the bearing of the weſtermoſt headland then lay 8 miles, taken from any ſcale of equal parts from A to D, then D is the place of the ſhip ſecond obſervation.

3dly, Lay a ſcale on the N. N. E. line before drawn, and draw a parallel thereto from D, to cut the N. W. line before drawn in C, the place of the weſtermoſt headland.

4thly, Again lay five points and a half from N towards E, and by it and A, draw a N. E. by E. half E. line, from D, to cut the aforeſaid N, N, E, line in B, the place of the eaſtermoſt head-land.

5th, Laſtly, lay ſix points from s towards E, and by it and A, drawn E. S, E, line, to cut the ſouth line A E, in E. the the place of the iſland, then draw the lines D E, D B, and D C, alſo drawing the lines E D, B C, and B E, which compleats the conſtruction for all the lines being meaſured on the ſame ſcale of equal parts A D was taken from, will ſhew their ſeveral diſtances, and meaſuring their ſeveral angles on the ſcale of chords you will have their ſeveral bearings as was required.

But to ſolve this queſtion by trigonometry, here are three triangles both in the preparative work and in the ſubſequent work to work in, and in the preparative work it is neceſſary to find the three diſtances, D s, D C, and D B, which being found by the ſolution of three triangles, in each of which their are all the angles and one ſide given, to find the other ſides; that is, in the triangle A S D, A D B, and A C D, where in the ſide A D, is common to all the three triangles, and having found either of the unknown ſides, in all the three ſaid triangles, you muſt proceed to the three ſubſequent triangles, which make nine ſeveral ſtatings, to perform the ſaid work as appears by the following work.

By Trigonometrical Calculation,

1ſt. In the right angled triangle A E D, are all the angles and one ſide given, to find the ſide A E, or E D, viz. angle D E A, equal ſix points, or 67 ,30. angle A D E, equal two points, or 22 ,30, and ſide A D equal eight miles, and angle D A E, equal 90 ,00.

As *S*, ∠ A B D	67 ,30	9,965615
Is to ſide A D	8	0,903090
So is Radius	90 ,00	10,000000
To ſide E D	8,658	0,937475
As Radius	90 ,00	10,
Is to ſide D E	8,658	0,937475
So is *S*, ∠ A D E	22 ,30	9,582339
To ſide A E	3,314	0,520314

2d,

2d. In the oblique angled triangle A D C, are all the angles, and one ſide given, to find either of the other ſides, viz. angle C A D equal four points or 45 ,00, angle C D A equal ſix points or 67 ,30, alſo the ſide A D eight miles.

If two angles are equal, their ſubtending ſides are equal whence the ſide A C equal A D equal eight miles.

		CO, AR,
As *S*, angle A C D	67 ,30	0,034380
Is to ſide A D	8	0,090305
So is S. ∠ C A D	45 ,00	9,849480
To ſide C D	6 ,123	0,756965

3d. In the oblique angled plain triangle B A D, are all the angle and one ſide given, to find the other ſides B A or D B, viz. angle B D A equal two points and a half, or 28 ,07, angle A B D three points and a half or 32 ,22, and angle B A D ten points 112 ,30. To find the ſides.

		CO, AR,
As S. angle A B D	39,32	0,197718
Is to ſide A D	8	0,903090
So is S. ∠ B A D	112 ,30	9,965615
To ſide B D	11 ,65	1,066425

		CO, AR,
As S. angle A B D	39 ,22	0,197718
Is to ſide A D	8	0,903098
So is S. ∠ B D A	28 ,07	9,673268
To ſide B A	5,944	0,774076

4th, In the oblique angled triangle B A C, are two ſides and an angle between them given, to find the other angles and the third ſide, viz. ſide A C, eight miles, ſide A B 5944, and the angle B A C 67 ,30, to find the angle B C A, and A B C, and ſide B.

Side A C	8	From	10 ,00	Half Z. angles	56 ,15
Side A B	5 ,944	Sub.	67 ,30	Half × of angle	12 ,27
Z. ſides	13 ,944	Sum	112 ,30	Angle A B C	68 ,42
× ſides	2 ,056	Half Z.	56 .15	Angle A C B	43 ,48

Angle A B C	68 .42	As Z, ſides 13 ,944	co. ar. 8.855737
Add	22 ,30	Is to ſide 2,056	0.313023
Sum	91 ,12	To half Z. ∠ 56 ,15	10,175107
Subt. from	180 ,00	To T. half × of angles 12 ,27	9,343867
Remains	88 ,48	As ſ. angle A B C 68 ,42	co. ar, 0,030728
The headlands bears N. 88 ,48 weſterly, or 11 88 .48 eaſterly, diſtance 7,933 miles.		Is to ſide A C 8	0,903090
		So is ſ, angle B A C 67 ,50	9,965615
		To ſide B C 7,933	0,899433

5th. In the oblique triangle A C E, there are two sides and an angle between them given or known, to find the other angles and the third side, viz. side A C 8 miles, side A E 3,314, and the contained angle E A C 135,00, to find the angles A C S, A S C, and the side C S, the distance between the westermost headland and the island.

				co, ar,
Side A C	8	As sum of sides	11,314	8,946284
Side A E	3,314	Is to difference of sides	4,686	0,670282
Z, sides	11,314	So is T, half sums angle	22,30	9,917222
× sides	4,686	To half × of angle	9,44	9,234108
From	180,00			co, ar,
Subt,	135,00	As S. angle A E C	32,55	0,272973
Sum	45,00	Is to side A C	8	0,903090
Half sum	22,30	So is S, angle C A E	135,00 (45,00)	9,849485
Half Z, angle	22,30	To side C E	10,6	1,025548
Half × angle	9,44			
Angle A E C	32,14			
Angle E C A	12,46			

The westermost headland and island bears N. 32,14 westerly, S. 32,14 easterly, distance 10,6 miles.

Lastly, In the oblique angled triangle A B E, there are two sides and an angle between them known, to find the other angles and the third side, viz, side A B 5,944, side A E 3,314, and the contained angle B A E 157,30, to find the angle A B E, A E B, and the side E B severally.

				co. ar.
Side A B	5,944	180,00		
Side A E	3,315	157,30	As sum of sides	9,258 9,033483
Z, sides	9,258	22,30	Is to difference of sides	2,63 0,419957
× sides	2,630	11,15	So is T. half of sum ∠	11,15 9,298662
			To T, half × of angles	3,15 8,752101
Half Z, angle		11,15		co. ar.
Half × of angle		3,15	As S. angle A B B	14,30 0,604400
Angle A E B		14,30	Is to side A B	5,944 0,774076
Angle A B E		8,00	So is . angle E A B	22,30 9,582849
			To the side E B	9,081 0,958316

The eastermost headland and Island, bears N. 14,30 easterly, or S. 14 30 westerly, their distance asunder being 9,081 miles, the rest of their bearing and distances are found in the aforesaid work.

Question

Queſtion 11th, A fleet of ſhips with four men of war, with the wind at W. by s, ſailed away s, E, three miles an hour, till hearing of ſome pirates to the northward of them, the Commodore ſends out a man of war a cruiſing, who ſails due north ſeven miles an hour, for the ſpace of eleven hours, and finding the pirate, after an hour conflict, took him, the fleet all the time ſailling s. E, three miles an hour; Now I demand what courſe the man of war and the pirate muſt ſteer that they may juſt fall in with the fleet, without altering her courſe, ſuppoſing they ſail ſeven miles an hour.

Geometrical Conſtruction. Pl. III, Fig, 135

Firſt, Draw the north and ſouth line C A, continued to B, then from A, the place where the fleet was when the heard of the pirates ſet off the s, E. line A E; then becauſe the cruiſing man of war ſailled ſeven miles an hour due due north for eleven hours that he was in chaſe viz. 77 miles; ſet off 77 miles from A to B, alſo by reaſon the commdore ſailed 3 miles an hour aforeſaid, and one hour they were engaged, in all makes 12 l. which at 3 m. an hour, is 36 miles s. E which ſet off from A to D, then is the commodore at D, and cruſer at B, when he ſet ſail after the commodore, now becauſe the line A E, is s, E. or 45 ,00, the angle B A D is 135 00, the ſide A B 77, ſide A D 36, to find the angle as is ſhewn in the queſtion foregoing.

Trigonometrical Calculation.

Side A B 77	From	180 ,00			co. ar,
Side B C 36	Sub.	135 ,00	As Z, ſides	113	1,946922
			Is to × of ſides	41	1,612784
Z, ſides 113	Z. ∠	45 .00	So is T, half Z, ∠	22 ,30	9.617224
× ſides 41	H.Z, ∠	22,30	To T, half × ∠	8,33	9,176930

Half of ſums angle		22 ,30			co. ar.
Half difference of angles		8 .33	As s. angle A D B	31,05	0,287531
			Is to ſide A B	77	1,886491
Angle A D B		31 ,03	So is s. angle B A D	135 ,00	9,849485
Adgle A B D		13 ,57	To the ſide B D	105,6	2,023507

Alſo the angle A D B being 31 ,03, the angle B D E muſt be 148,57 and altho' the ſides B E and D E, are not given yet, their proportions to each other are given, viz. as 7, to 3, ſo is B E, to D E, then,

		co. ar.	To angle B E	148 ,57
As ſide BE	7	9,154902	Add D B E	12 ,46
Is to s. angle BDE	148 ,57	9,344492	Subtract	161 ,43
So is ſide DE	3	9,477121	Subtract from	180 ,00
To S. angle DBE	12 ,46	9,344492	Remain angle DEB	18 ,17

Hence

Hence we have the angles B D E and B E D, and side B D equal 105,6, to find the side B E, the diſtance ſailed by the cruiſer and pirate, to meet with the fleet.

As s, angle D E B	18 ,17	co. ar.	0,503463
Is to the ſide D B	105,6		2,023507
So is s. angle B D E	148 ,57 (31 ,03)		9.712466
To the ſide B E	173,6		2,239439

The whole angle A B E equal 26 ,43, is the courſe from the S. eaſtward, or S, S. E. 4 ,13 eaſterly, that the cruiſer muſt ſail to fall in with the fleet, and his diſtance 173,6 miles, before he comes in with them, which at ſeven miles an hour, would require almoſt 25 hours, to fall in with the fleet as wes required,

Queſtion 12th, The wind at ſouth, and a ſhip of war in ſight of a headland, bearing N. E., 7 leagues, was ordered by the commodore, to weather it, ſo as to reach an iſland three leagues to windward of the ſaid iſland at two boards, having then her ſtarboard tacks aboard, and can make her way good within ſix points of the wind; I demand how far ſhe muſt run upon that tack. before ſhe goes about, with her larboard tacks, to bring the head land three leagues to leeward.

This queſtion was propoſed in Kelly's appendix to his navigation, without a ſolution, and as I have here attempted to anſwer it, the reader may conſider that if the wind is ſouth, and the headland bearing N. E, diſtance 7 leagues, and the iſland be three leagues, to windward of the headland, it doth not appear that he had occaſion to apply to windward to gain the iſland, ſo I therefore ſuppoſe there is an error, which I ſhall correct by ſuppoſing the headland to bear S. E. and the iſland three leagues due ſouth of the headland, as appears in the annexed figure.

The Geometrical Conſtruction. Pl. 3.Fig. 130

Draw the S. E. quarter, and the s. E. line A B ſeven leagues. and parallel to A s, make B C equal three leagues, and draw A C, then lay ſix points from s. towards E, and draw the E, s, E, line at pleaſure again from C, draw an E, N. E. line to cut A D in D, the place where ſhe tacked about, and the figure is projected,

Trigonometrical Calculation.

1ſt. In the oblique Triangle A B C, there are two ſides and an angle between them given to find the other angles and the ſide A C, viz, the ſide A B 7, B C 3, and angle A B C 135 ,00

Side

Side A B	7			co. ar.
Side B C	3	As half ſum of ſides	10	1,000000
		Is to × of ſides	4	9,602060
Z. of ſides	10	So is T. half ſum angle	22,30	9,617224
× of ſides	4	To half × of angle	9,24	3,219284

From	100,00			co. ar.
Subtract	135.00	As angle A	13,06	0,644642
		Is to C B	3	0,477121
Z, angles	45,00	So is angle B	45,00	9,849454
Half ſum	22,30	To A C	9,34	0,971217

22.30 + 9,24 equal 31,54 | 22,30 — 9.24 equal 13,06

Hence the diſtance A C is 9,34 miles. 2d In the oblique triangle A D C, are all the angles and ſide A C known, to find the ſides A D and D C, viz. angle D A C 45 .00 and angle A D C 98 .45, and ſide A C 9.34 miles.

		co, a,		co ar.
As s. ∠ A D C	45,00	0,150515	As s, ∠ A D C 45,00	0,150518
Is to A C	9,36	0.9/1248	Is to ſide A C 9,36	0,971248
So is s, ∠ D A D	35,36	9,785015	So is s, ∠ A C D 81,12	9,996779
To ſide D C	8,068	9.906778	To ſide A D 13,1	1,118535

Anſwer, She muſt run 13,1 leagues, before ſhe tacks, and then afterwards 8,068 leagues, upon ſecond tack,

Queſtion 14. Suppoſe two ſhips ſails from one port, the firſt ſhip ſails due ſouth, and the other W S W more than the firſt 35 leagues, and then were 76 leagues aſunder, I demand how many leagues each ſhip had ſailed.

By ſimular figures it is plainly apparent that the triangle A B C is Iſoſceles, the angle B A C being 67 30 which ſubtracted from 180 00 remains 112 30, half thereof being 56 15 equal the angle A B C or A C B then 180 — 56 15 equal 123 45 equal angle D B C then in the Δ D B C we have two ſides and an angle oppoſite, given to find the angles D and C and the ſide B C equal A B.

		CO, AR,		CO, AR.
As ſide D C 76		8,119186	As S an. B C D 22 31	0,416900
Is to S an. D B C	123 45	9.919846	Is to ſide B D 35	1,544068
So is ſide D B 35		1.544368	So is S an. B D C 33 44	9,744550
To S an. B C D	22 31	9,583100	To the ſide B C 50 76	1,705515

Then

Then in the iſoſcles triangle A B C, the angle A equal 67 .30 the angle B equal angle C equal 56 ,15, and ſide B C equal 50 .76; to find the ſide A C.

As *S.* angle A.	67 ,30	co. ar.	0.034355	*Anſwer.*
Is to ſide B C	50 ,76		1,705518	The firſt ſhip
So is s. angle B	56 ,15		9.919846	failed 45 .68 the
				ſecond 80 ,68 lea,
To the ſide A C	45 .68		1.659749	

Queſtion 14th, Two ſhips ſailed from one port the firſt ſail S, S, W. a certain diſtance; then altering her courſe ſhe ſailed due eaſt 92 leagues, the ſecond ſhip ſailed 120 leagues, and meet with the firſt; I demand the ſecond ſhip's courſe, and how many leagues the firſt ſailed upon the S. S, W, courſe.

Geometrical Conſtruction. Fig. III, *Pl,* 141,

Firſt, draw a S, S, W, line *a c*, at pleaſure, aud from any point c, draw a due weſt line B C. which make 92 from any ſcale of equal parts, then with the extent of 120 miles, in your compaſſes, and one foot in B, cut the aforeſaid line A C in A, and draw the line C A, and its done.

Trigonometrical Calculation.

In the oblique triangle A B C, there is given the ſide A B equal 120, B C equal 92, and angle A B C 112 ,30; to find the other angles and the third ſide.

As ſide a c	120	co, ar,	7,920819	Angle C	112 ,30
Is to s, angle c	112 ,30		9,965615	Angle A	45 ,06
So is ſide B c	92		1,963788		
				Sum	157 ,36
To s, angle a	45 ,06		9,850222		180 ,00
As s, angle A	45 ,06			Angle B	22 ,24
Is to ſide B C	92			Anſwer, ſecond ſhip's courſe	
So is s, angle B	22 ,24			W, *S*, W, the firſt ſhip's diſtance	
To the ſide A C	4,95			49 leagues, as was required.	

Queſtion 17, Suppoſe two ſhips ſails from two ſeveral ports in the ſame parallel of latitude and 90 leagues diſtance aſſunder, the weſtermoſt ſails N, E, by E, the eaſtermoſt ſhip ſails in the N, W, quarter, till ſhe meets with the firſt, if the diſtance run by both ſhips be added together, their ſum will be 133 leagues; required what the diſtance are ſeverally.

The

Geometrical Conſtruction. Fig. III, *Pl.* 141,

Make the line A C 90, the diſtance of the ports, and the angle B A C equal 33,45, equal comp. weſtermoſt ſhip's courſe, and make B A, equal 133 leagues, and draw B C, then biſect B C in *d*, and make *d* D, perpendicular to B C, cutting A B in D, the place where the ſhips meet, then is A D, the weſtermoſt ſhip's diſtance, C D, equal the eaſtermoſt ſhip's diſtance, which taken from the ſame ſcale of equal parts before uſed, will ſhew what they are.

Trigonometrical Calculation.

1ſt, In the oblique triangle A B C, are two ſides and an angle between them given, to find the other angles and the third ſide, viz. ſide A B equal 133, ſide A C equal 90, and angle B A C equal 33,45.

			co. ar.	
Side A B 133				
Side A C 90	As ſum of ſides	223	7,651695	73 ,07
	Is to × of ſides	43	7,632468	32 ,26
Sum ſides 223	So is T. half Z. an.	73,07	10,517837	
				105 ,33
× ſides 43	To half × angles	32 ,26	9,802996	

From	180 ,00	Half Z, angle	73 ,07		
Sub.	33 ,45	Half × of angles	32 ,26	As s, angle C	40 ,41
				Is to ſide A C	90
Z, angles	146 ,15	Angle C	105 ,33	So is s, angle A	33,45
				To the ſide B C	76,7
Half Z, ∠s	73,07	Angle B equal	40 ,41		

2d. In the iſoſcles △ D C B, are known all the angles and the ſide B C, to find the other ſides D B equal D C.

Angle B = 40 ,41 × 2 = 81 ,22 = ſum of the equal angles.

To find the ſide D C.				
		co. ar.	From	105 ,33
			Subtract	40 ,41
As s. angle A B C	81 ,22	0,004549		
Is to ſide B C	76,7	1,884816	Remains	64 ,52
So is s, angle B	40 ,41	9,814165	Subt. from	90 ,00
To the ſide D C	50,5	1,703530	Remains	25 ,08

Anſwer, The firſt ſhip's diſtance 82,5, the ſecond ſhip's diſtance is 50,5, and her courſe N, 25 ,08 weſterly.

Queſtion 17th, Three ſhips are at three ports, the eaſtermoſt ſhip is diſtant from the northermoſt 75 miles, and bears from her S. E. by *S*, the weſtermoſt is diſtant from the northermoſt 85 miles, and bears S. S, W, from her, and are all bound to an iſland that is at an equal diſtance from them; I demand each ſhip's courſe and diſtance to the ſaid iſland.

The Geometrical Conſtruction. Pl. 3. Fig. 142

By having two ſides given, and an angle between them, the triangle is eaſily made, then deſcribe a circle through the three points A, B, and C, of the triangle, and draw out lines from theſe points to the center of the circle, and the triangle is finiſhed; for D, being the place of iſland, and the radii A D, B D, and C D, their equal diſtances, and the angles A B D, A C D, and C B D, will be their ſeveral courſes, which may all be meaſured by help of the chords and equal parts.

By Trigonometrical Calculation.

The oblique triangle A B C, are two ſides and an angle between given, to find the other angles and third ſide B C, viz. A B equal 75, A C equal 85, and angle B A C equal five points or 56 ,15, to find the other angles and ſide B C.

Side A C	85	From	180 ,00		
Side A B	75	Sub.	56 ,15		
Z. ſides	160	Sum	123 ,45	As Z. of ſides	150
				Is to difference of ſides	10
				So is T. half Z. ∠	61 ,52
× ſides	10	Half Z.	61 ,52	To T. half × of angles	6,40

61 ,52 + 6,40 = 68 ,32 = angle A B C
61 ,52 — 6,40 = 55 ,12 = angle A C B.

Then ſay,		co. ar.
As S. angle A C B	55 ,12	0,080578
Is to ſide A B	75	1,875061
So is S. angle B A C	56 ,15	9,919846
To the ſide B C	75 ,94	1,880485

2d. In the iſoſceles Δ C D B, are all the angles and ſide B C known, viz. angle C D B equal 2 angle C A B equal 112 ,30, and each of the equal angles equal half of 56 ,15 equal 28 ,07. and ſide B C 75 ,94 to find C D equal B D equal A D, each ſhip's diſtance to the ſaid iſland.

Then

Then ſay,		co. ar.
As *S.* angle C D B	56 ,15	0.080154
Is to ſide C B	75 ,94	1,880485
So is s. angle D B C	28 ,07	9.673268
To the ſide D C	43.5	1.633907

Anſwer, Northermoſt ſhip's courſe ſouth, the weſtermoſt ſhip's courſe N.52,27 eaſterly, and eaſtermoſt ſhip's courſe N, 62,32 weſterly, their equal diſtance ſailed 43,5 miles,

Queſtion 19th, Admit two ſhips at one and the ſame inſtant of time had ſailed from one port, the one ſailed N. W. by N. 6 leagues in a watch, and the other ſails N, E. 8 leagues in a watch, and they arrived at two ſeveral ports, at one and the ſame inſtant of time, the ports being 158 leagues aſſunder; I demand each ſhip's diſtance ſailed, the bearing of theſe two ports, and time they were in ſailing to them?

A General Solution.

Firſt by ſuppoſing a ſimilar triangle whoſe ſides A B equal 6, A C equal 8, and angle B A c equal 7 points or 78 ,45, and let it be required to find the other angles and third ſide b c, in proportion to them.

Side A C	8	From	180 ,00
Side A B	6	Subt,	78 ,45
Sum of ſides	14	Sum of angles	101 ,15
Difference of ſides	2	Half ſum of angles	50 ,37

As ſum of ſides	14
Is to difference of ſides	2
So is T, half Z, ∠	50 ,37
To T, half × ∠	9,52

50 37 + 9,52 = 60.26 = ∠ B.
50 .37 — 9.52 = 40 .45 = ∠ C.

Then to find the ſide required.

		co. ar.
As s. ang. A	78 ,45	0.008426
Is to ſide B C	158	2,198657
So is s. angle C	40 ,45	9,814753
To ſide A B	105,1	2,021836

Angle C	40 ,45
Add	45 ,00
Sum	85 ,45

As S. angle A	78 ,45	
Is to ſide B C	158	
So is S. ∠ B	60 ,29	
To ſide A C	140,2	

Anſwer, The weſtermoſt ſhip's diſtance is 105,1, Eaſtermoſt 140,2, their bearing is N. 85 ,45 eaſterly, and the time in ſailing 35 ,05 hours, as was required.

Queſtion

Queſtion 20th, Admit a ſhip ſails from Pico of Fyal, firſt N. E. by E. a quarter E. then N. W. a quarter W. then ſouth, and ſo returned again to Fyal, having ſailed in all 158 leagues, required then how many leagues ſhe ſailed upon each courſe.

Solution. Having firſt prepared a ſimilar triangle, whoſe ſides let be eſteemed in ratio, of the natural ſines of the given angles, that is natural ſine of angle A equal .8578 natural ſine of angle B equal ,6715, and natural ſine of angle C equal .9578 then as the ſum of theſe proportional numbers, is to ſum of all the ſubtending ſides, ſo is any one of the ſaid numbers, to its reſpective ſide.

		Then ſay,
Angle B	.6715	
Angle A	,8578	
Angle C	.9570	2,4863 : 6715 : : 158 : 42 ,672
		2,4863 : 8578 : : 158 : 54 ,511
Sum	2,4863	2,4863 : 9570 : : 158 : 60 ,815

Anſwer. The ſhip ſail'd { 42 ,672 / 54 ,511 / 60 ,515 } Leagues upon the { N. E. by E. $\frac{1}{4}$ E. / N. W. $\frac{1}{4}$ W. / South }

Queſtion 21ſt, Two ſhips in the ſame latitude, diſtant 600 miles, the firſt ſailed N, eaſterly, the ſecond ſails N. weſterly, till they meet, and at their meeting they make an angle of 102 .10. and the firſt ſhip had ſailed 162 miles more then the other; I demand each ſhip's courſe and diſtance.

The Geometrical Conſtruction. Pl, III, Fig, 147

Make the baſe A B equal 600 miles, the given diſtance of the two ſhips, and biſect the baſe A C in *d*, and let fall the perpendicular *d a*, at pleaſure, then make the angle A C *a*, equal $\frac{102\ .10}{2}$ equal 51 ,05 and draw C *a*, to cut *d a*, in *a*, then upon *a*, as a center, deſcribe the ſegment of a circle A D C, which contains an angle of 141 .05 equal 90 + 51 ,05, then lay 162 from A to D, on the ſegments arch, and draw A D continued at pleaſure, alſo draw B C to cut A D, continued in B, then will A B C, be the triangle required.

Trigonometrical Calculation.

1ſt, In the oblique angled triangle A D C, there are two ſides and an angle oppoſite to one of them, viz. A C 600, A D ebual 160, and angle A D C equal 141 ,05, to find the ſide D C and angles D A C, and D C A.

As

As ſide A C	600	As S angle c	9,39
Is to S angle A D C	38 ,35	Is to ſide A D	160
So is ſide A D	160	So is S angle A	29 ,16
To S angle A C D	9,39	To the ſide D C	466

Angle A D C	141 ,05
Add	9 ,39
Sum	150 ,44
Subtract from	180 ,00
Angle A	29 ,16

2d. In the Iſocles D B C there are all the angles, and ſide D C, known, viz. D C ebual 466, angle B equal 102 ,10, hence angle c equal angle D 38 ,35.

To find the ſide B C.

As S. angle B	102 ,10 (77 ,50	Anſwer, The firſt ſhip ſails N, 60 ,44 eaſterly, diſtance 462 miles, the 2d. ſhip ſails N. 29 ,16 weſterly, diſtance 300 miles.
Is to ſide B C	466	
So is S angle D	38 ,55	
To ſide B C	300	

Queſtion 21ſt, Suppoſe two ſhips ſails from one port, one ſails N N, W. the other ſails N. W, by W. to two iſlands, bearing from each other N. E. by E. and S. W. by W. diſtant 80 leagues; I demand the diſtance each ſhip muſt ſail to thoſe iſlands.

Geometrical Projection. Pl. III. Fig. 148.

Draw a circle with the chord of 60, and quarter it with two diameters, placing N E W S, as before has been directed, then draw the N. E. by E. line equal 8 leagues, from a ſcale of equal parts, then lay five points from S, towards E, and draw a S. E. by E, line at pleaſure, again lay two points from S towards E, and draw an obſcure S. S. E. line, and parallel thereto, draw the line B C and cut A C in c, the port where the ſhips ſailed from; then c B repreſents the ſhip's courſe and diſtance that ſailed N. N. W. and c A, repreſents the ſhip's courſe and diſtance that ſailed N. W. by W.

Trigonometrical Calculation.

In the oblique triangle △ A B C, all the angles and ſide A B, are given to find the ſide A C and B C.

As *S*, angle C	33 ,45	As s. angle c	33 ,45
Is to ſide A B	80	Is to ſide A B	80
So is S. ∠ A	67 ,30	So is s. angle B	78 ,45
To the ſide B C	133	To the ſide A C	141,3

The firſt ſhip ſailed 133 leagues; Second ſailed 141,3 leagues.

Queſtion 22d, Suppoſe a ſhip ſails north a certain diſtance, then E, N, E, 80 miles, and S, E, a certain diſtance, laſtly S. W. by S.

160

160 miles, and then arrived at the place ſhe ſailed from; I demand how many miles ſhe ſailed on her north and S. E, courſes.

Geometrical Conſtruction. Pl. III, Fig, 135

Firſt, draw the north and ſouth line, A D B at pleaſure, and make the angle D A B equal 33 ,45, and make A B equal 160 miles, and make the angle C B A equal 101 .15, and draw B C continued to cut A D E in E, then by the queſtion we have angle E D C equal angle E C D, whence the △ D E C, is iſoſceles, then let fall the perpendicular E *d*, by biſecting the angle C E D in E, then by reaſon the diſtance E N E is 80 miles, take 40 in your compaſſes, with which draw an obſcure line parallel to the perpendicular E *d*, to cut B C in c, and E D will be equal E C, and the projection is finiſhed.

Then is the angle E D C equal 6 points or 67 ,30, and D C equal 80 miles, and A D and D C, meaſured on the ſame ſcale of equal parts, before uſed, will ſhew the diſtances required.

Trigonometrical Calculation.

1ſt. In the oblique triangle A B E, we have all the angles and one ſide given, viz. angle B E A equal four points or 45 ,00, angle E A B equal three points or 33 ,45, and angle A B E equal nine points, or 101 ,15, and ſide A B equal 160, to find the ſides A E and B E.

Then ſay,		Again,	
As s, angle E	45 ,00	As s. angle E	45 ,00
Is to ſide A D	80	Is to ſide A B	160
So is s, ∠ B	78 ,45	So is s. angle A	33 ,45
To ſide A E	222	To the ſide B E	126

Again, in the iſoſcles △ D C E, we have all the angles and one ſide given, viz. angle E D c, equal angle E C D, equal 67 ,30; and D E C, equal 45 ,00; alſo the ſide D C equal 80, to find the ſide D E equal E C,

Then ſay,		222	126
As s. angle E	45 ,00	105	105
Is to ſide D C	80		
So is s, angle D	67,3	117 equal A D	21 equal B C:
To the ſide C E	105	Anſwer, ſhe ſail'd N. 117 m. and S. E, 21 m. as was rebuired.	

Queſtion 23d. Suppoſe a ſhip at D, to ſpy three headlands, A B and C, from A to C, is 7 leagues, from B to C 60 leagues, and from C to A is 50 leagues, C bears from the ſhip N. 18 ,13 eaſterly, A bears N. 17 ,50 weſterly, and B bears from her N. 36 eaſterly; I demand the

the diſtance the ſhip was from theſe iſlands A B and C, and the bearings of each one from another.

Geometrical Conſtruction.

Firſt, deſcribe the triangle ABC, then at A, make an ∠BA E equal ∠ B D C, and ∠ A B E equal △ A D C, and draw the line A E and B E, to interſect each other in E, then through the three points A E B, diſcribe the circle A E B, then draw E C, produced to cut the circle D, the place of the ſhip in the time of obſervation; alſo draw A D and B D, and the projection is finiſhed; for A D, B D, and B D, meaſured on the ſame ſcale of equal parts the triangle was taken from, will ſhew their ſeveral diſtances required.

In the △ A B C, all the ſides are given to find the angles, viz, A B 70. B C 60, A C 50; operation, let fall the perpendicular C.

B C	60			70,0000
A C	50	70 : 110 : : 10 : 17,71428		15,7143
Z ſides	110	equal of the ſegments of the baſe. Then		85,7143
X ſides	10	B C 42,85 | A C 27,14	:	54,2857

As ſide A C	60	As ſide A C	50
Is to Radius	90,00	Is to Radius	90,00
So is ſide B C	42,81	So is ſide A C	27,14
To *S*, ∠ B C C	45,38	To *S*, ∠ A C C	32,53

From	90,00	From	90,00
Subtract	45,35	Subtract	32,53
∠ A B C	44,25	Angle B A C	57,07
		Hence angle A C B equal	78,28

Secondly, In the oblique angled triangle A E B, are all the angles and ſide A B known, to find the ſides A E and B E. viz, angle A B E 36.30, angle E A B 17 50, and ſide A B equal 70.

Angle ABE	36,30		
Angle EAB	17,0	To find ſide A E.	To find ſide B E.
Z angles	54,20	As s. an. AEB 54,20	As s. an. AEB 54,20
Subt. from	180,00	Is to ſide A B 70	Is to ſide AB 70
		So is s. an ABE 36,30	So is s. an. EAB 17,56
Angle AEB	125,40	To ſide A E 51,26	To the ſide E B 26,39

3dly.

3d. In the oblique triangle B A C, are two sides and an angle beween them given, viz. B C 60, B E 26 ,39, and angle E B C 81 ,55, to find the other angles.

From	180 ,00	Side B C	60
Subtract	81 ,55	Side B E	26 .39
Z angles	98 ,04	Z, sides	86 ,39
Half Z of angles	49 ,05	× of sides	33 ,61

To find the Difference of the required Angles.

As the sum of sides	96 ,39	Half sum of angles	49 .02
Is to difference of sides	33 .61	Half difference of angles	24 ,03
So is T. half sum angles	49 ,02	Angle B E C	73 ,10
To T. half × of angles	24 ,08	Angle E C B	24 ,54

4th. In the oblique triangle △ A E C, are given, two sides and an angle between them, viz, A E 51 ,26, A C 50, and the angle C A E 69 ,24, to find the other angles.

Side A E	51 .26	$\frac{110,46}{2}$ = 55 ,18 half Z. angle:	
Side A C	50 ,00		
Sum of sides	101 ,26	As sum of sides	101 ,26
Difference of sides	1 ,26	Is to difference of sides	1 ,26
180 ,00 — 69 ,24 = 110 ,39		So is T. half sum of angles	55 ,18
		To T. half × of angles	0 ,52

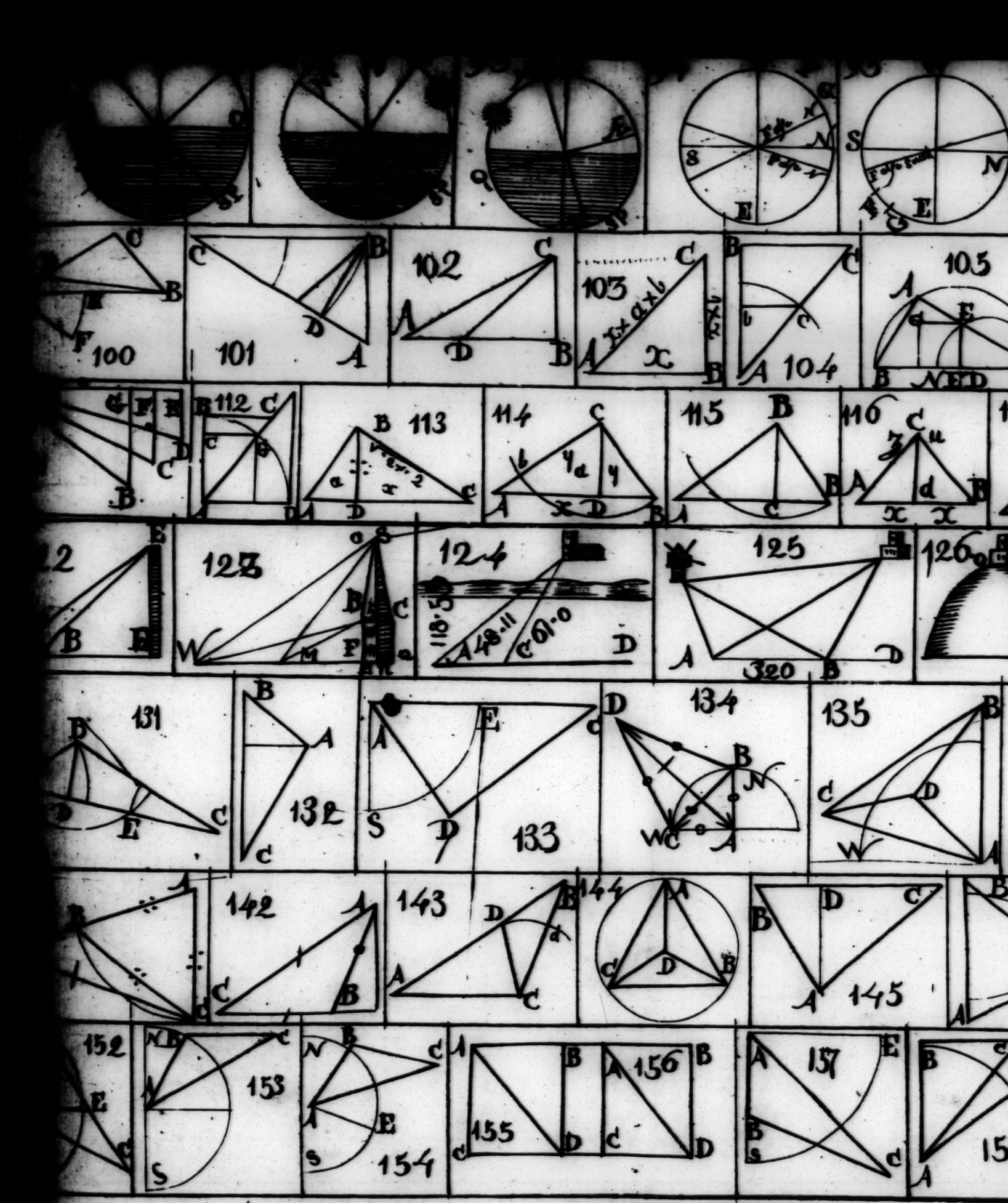
55 ,18 + 0 ,52 = 56 ,10 ∠ C | 55 .18 — 0 .52 54 ,26 ∠ E,

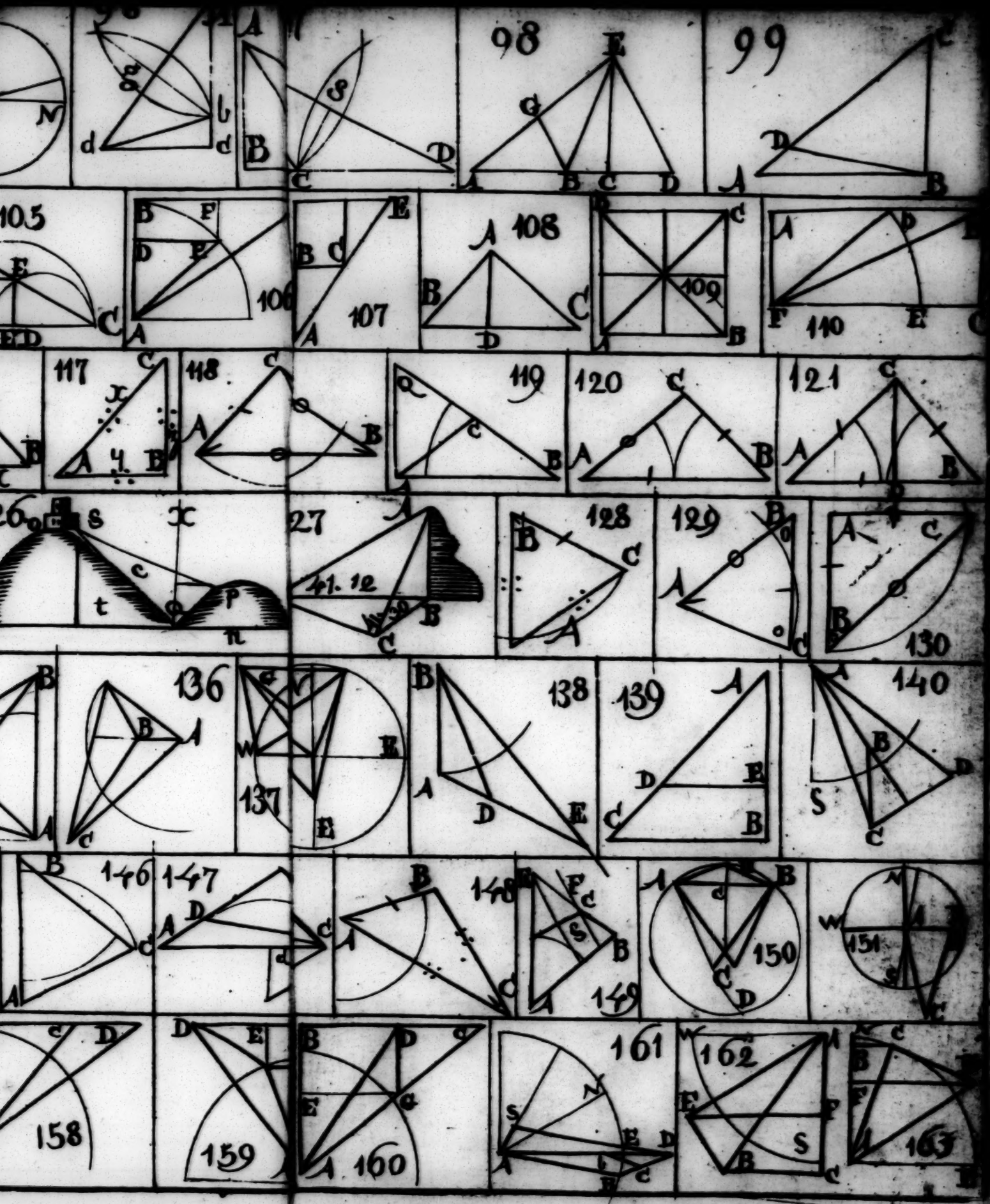
In the oblique triangle △ D C B, there is given two angles and a side opposite to one of them, viz, angle D C B 155 ,06, angle C D B 18 ,17, and side B C 60, to find their subtending sides D B and D b.

From	180 .00	From	24 ,54
Subtract	24 .54	Subtract	18 ,17
∠ D C B	155 ,06	Rem. ∠ B	6 ,37

As S. angle B D C	18 ,17	As S. angle D	18 ,17
Is to side B C	60	Is to side B C	60
So is S. angle C D B	24 ,54	So is S. angle B	6,37
To the side D B	80,5	To side D C	22

Lastly,


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Laſtly, In the oblique triangle ACD, we have given, the angle ADC 36 ,03, the angle ACD equal 123 ,50, and ſide AC equal 50, To find the ſide AD.

As s, angle ADC 36 ,08.
Is to ſide A C 50
So is s, an. ACD 56,10
To the ſide AD 71

Anſwer, The ſhip's diſtance from the weſtermoſt headland 71 miles, her diſtance from the midlemoſt 22 miles, her diſtance from the eaſtermoſt 80,5, C bears from B, S 45 ,35 weſterly, C bears from A, S. 32 ,52 eaſterly, and A and B, bears due eaſt and weſt of each other.

Turning to WINDWARD, in Oblique Sailing.

We ſhall now give ſeveral Queſtions in this kind of ſailing, uſeful to gain a Port in the ſhorteſt time when the Wind is contrary.

A Ship ſailing to windward, will uſually lye within five and a half or ſix points from the wind, but by reaſon of the lee-way, ſhe will ſcarce make her way good, with her top-ſails ſet, within ſix and a half or ſeven points from the wind, ſometimes more ſome times leſs, according as the ſea is rough or ſmooth, and according to the mould of the ſhip, and the ſail ſhe carries; ſo that in ſailing to a place directly to windward, ſhe uſually ſails three or four times the diſtance of that place, before ſhe arrives at it. But if the place ſhe be bound to, lie not directly to windward, but within 1, 2, 3, 4, 5, or 6, points of the wind, then though ſhe turn to windward as before, yet ſhe will ſooner arrive at the place than before, but how, and in what proportion, for the one, and alſo for the other, may fully appear by the following problems or queſtions.

Queſtion 1ſt. Suppoſe the wind at eaſt, and a ſhip bound to an iſland 400 leagues directly to windward, making her way good within ſix points and three quarters. or 75 ,56 of the wind, when variation and leeway are allowed; required the diſtance ſhe muſt ſail upon each tack to gain that iſland.

The Geometrical Conſtruction. Pl. 3. Fig. 151

The circle being deſcribed and quartered as before, ſet off 400 leagues from the center A, to the iſland, and draw A B, the diſtance from the ſhip to the iſland, and draw A B the diſtance from the ſhip to the iſland, then ſet ſix points and three quarters or 75,50 from E, the eaſt point both ways towards the north and ſouth, and draw the rhumb lines through theſe points, as A C, and A D, ſhewing how the ſhip will lay on each tack.

From the point B, draw B C, parallel to A D, to cut A C in C, the point where the ſhip tacks, there A C is the larboard tack, and B C, is the ſtarboard tack, the diſtance of each being equal, becauſe the oppoſite angles A and B, are equal, or without the circle one may project thus, make A B 400 equal parts, and the angles B A C, and A B C, each equal 75 ,56, and draw A C, and B C, to interſect each other in C, the place where the ſhip tacks.

By Trigonometry thus,

Angle B + ∠C equal 151 ,52, and 180,00—151,52=28,08, then ſay,

As S. angle C	28 ,08	Anſwer, She muſt run 822,9 leagues on the larboard tack, and 822,9 on the ſtarboard tack, to gain the iſland.
Is to ſide A B	400	
So is S. ∠ A	75 ,56	
To the ſide B C	822,9	

Queſtion 2d. The wind N. E. and a ſhip plying to windward, having run 822,9 miles, with her ſtarboard, and 822,9 miles with her larboard tack on board, is arrived at a port, 400 miles directly to windward; I demand how near the wind ſhe makes her way good?

The Geometrical Conſtruction. Pl. III. Fig. 151

The circle being deſcribed and quartered, as before directed, makes the N. E. line A B 400 equal parts, then with 822,9 equal parts in your compaſſes, and one foot in A, deſcribe an arch, with the ſame extent and one foot in B, deſcribe an arch to croſs the former arch in C, the place where the ſhip tacked about, and draw the lines C A, and B C, which are the diſtance upon each tack, and the angle B A C, meaſured on the line of chords, will ſhew 75 .56, from the wind as required.

By Trigonometry thus,

Let fall the perpendicular *c d* from *c* on A B, and it will divide the baſe A B equally in *d*, and the iſoſcles triangle into two equal right angled triangles A C D and B C D, in each of which we have given A C, or B C equal 822.9 miles, and A *d* equal half A B equal 200, to find the angle A or B, by caſe 5th of plain ſailing.

As ſide A C	822,9	2,915333	To	45 ,00	
Is to Radius	90 ,00	10,000000	Add	75 .56	equal angle A
So is ſide A *d*	200	2,301030		120 ,56	Sum
To S. ∠ A C *d*	14 ,04	9,385697		180 ,00	Subtract from
	90 ,00			59 ,04	Remains
Rem. Angle A equal an. B.	75 ,56			28 ,08	equal angle A C B
				30 ,56	

Anſwer,

Anſwer, She lies 75 ,56 from the wind, and her courſe upon the larboard tack is S. 59 ,40 eaſterly, and on her ſtarboard tack, is N. 30 ,56 weſterly, as was required.

Queſtion 3d, Admit a ſhip is bound to a port that lies N. N. E. half E. diſtant 575 leagues, the wind being N. by W. and ſhe can lay no nearer the wind than ſix points and three quarters, or 75 ,56; I demand her diſtance upon each tack to gain the ſaid port?

Geometrical Conſtruction. Pl. III, Fig, 152

The circle being drawn and quartered as before, ſet off one point from North to weſtward, and draw the wind line A W, ſet off ſix points and three quarters, or 75 ,56 on each ſide of the line to *u* and *t*, and draw A *u*, and A *g*; again, draw a N. N. E. half E. line A B, on which ſet off 375, from A to B, the ſhip's diſtance from the port, and through B, draw B C, parallel to *u* g, till it meet *u t*, produced in C, then will A C and B C, be the diſtance on each tack required.

It is evident here, the ſhip lies up with her larboard tack N. E. by E. three quarters E. and on her ſtarboard tack W. by S. three quarters W. therefore from N. N. E. half E. to N E. by E. three quarters E. is three and a quarter, or 36 ,34 equal angle B A C, and from *g t u*, a W. by S. three quarters W. line, ſubſtract A e, a S. W. by W. three quarters W, line, and there remains two and a half points, equal angle A C B, then B A *u*, is a S. S. W, half W. line, B e parallel to A g, is an E. by S. three quarters E. line, and from the S. S. W half W. line, to the E. by S. three quarters E, line, is ten and a quarter points, or 115 ,18, equal angle A B C, ſo we have all the angles A B and C, and the oppoſite ſide A B, to find the other ſides by the Firſt axiom of oblique triangles.

By Trigonometry thus.

Then ſay,		Again,	
As s, angle C	28 ,07	As s, angle C	28 ,07
Is to ſide A B	375	Is to ſide A B	375
So is s, ∠ A	36 ,34	So is s, angle B	64,41
To ſide B C	474,1	To the ſide A C	719,1

Queſtion 4th. The wind at N. by W. and ſuppoſe two ports lie N. N. E. half E. and S. S. W. half W. diſtant 375 leagues, a ſhip ſails from the ſouthermoſt, cloſe hawled upon a wind 719,1 leagues, with her larboard tacks on board, and 474,1 leagues, with her ſtarboard tacks on board, and then arrives at the northermoſt port; I demand how near the wind ſhe makes her way good upon each tack.

Geo-

Geometrical Conſtruction. Pl. III. Fig. 148.

The circle being deſcribed and quartered, and the wind line A *c o*, ſet off as in the laſt queſtion draw a N. N. E. half E. line, and make A B equal 375 leagues, or equal parts (the diſtance of the ports) make A C equal 719,1 leagues, and B C equal 474,1 leagues, and let fall the perpendicular B P, and make P s, equal P A, ſo ſhall C s, be the difference of the ſegments of the baſe A C, as in the fourth axiom of oblique trigonometry.

Trigonometrical Calculation.

B c	474,1
A B	375
Sum	849,1
× ſides	99,1

719,1 : 849,1 : : 99,1 : $\frac{849,1 \times 991}{719}$ equal 116,9. the difference of the ſegments of the baſe.

Then $\frac{719,1 + 116,9}{2}$ equal 418, equal C P.

And $\frac{719,1 - 116,9}{2}$ equal 301,1 equal A P.

As hypoth. A B	373	As hyp. B C	474,1
Is to Radius	90,00	Is to Radius	90,00
So is the baſe A P	301,1	So is baſe B p	418
To S. angle A B P	53 25	To S. angle P B C	61,51
Subtract from	60,00	Subtract from	90.00
Remains angle B A P	36,35	Remains ∠ A C B	28,09

That is three points and a quarter, 36 .35, from N. N, E. half E. which added to three points and a half, makes ſix and three quarters from the wind on the larboard tack, and the ſame thing on the ſtarboard tack, as was required.

SAILING IN CURRENTS.

CURRENTS are certain ſettings of the ſtream at ſea, or the tide in a river, by the means of which all bodies, as ſhips or boats more therein, are compelled to alter their courſe, velocity, or both, and ſubmit to motion impreſſed upon them by the current.

If the current ſets juſt with the courſe of the ſhip, that is moves on the ſame rhumb with it, the motion of the ſhip is increaſed by as much as is the drift, or velocity of the current.

Caſe 1ſt. If the current ſets juſt with the courſe of the ſhip, that is moves in the ſame rhumb line with it, then the motion of the ſhip is increaſed by as much as is the drift, or velocity of the current.

Ex-

Example, Suppoſe a ſhip ſails S. E. by E. at the rate of ſix miles an hour, in a current that ſets S. E. by E. two miles an hour, required her true rate of ſailing.

Here it is evident that the ſhip's true rate of ſailing will be 8 miles an hour.

Caſe 2d. If the current ſets directly againſt the ſhips courſe, then the velocity of the ſhip is leſſened by as much as is the velocity of the current.

Example, Suppoſe a ſhip ſails S. S. W. at the rate of ten miles an hour, in a current that ſets N. N. E, ſix miles an hour, required the ſhip's true rate of ſailing.

Here it is evident that the ſhip's true rate of ſailing will be four miles an hour.

Cor. 1ſt. If the velocity of the current be leſs than the velocity of the ſhip, then the ſhip will get ſo much as is the difference of their velocities.

Cor. 2d. If the velocity of the current be greater than the velocity of the ſhip; then the ſhip will fall ſo much a ſtern, as is the difference of their velocities.

Cor, 3d. Laſtly, if the velocity of the current be equal to the velocity of the ſhip, then the ſhip will ſtand ſtill, the velocity of the one deſtroying the other.

Caſe 3d, If the current thwarts the courſe of the ſhip, then it not only leſſens or augments her velocity. but gives her a new direction compounded of the courſe ſhe ſtears, and the ſetting of the current, as is evident from the following lemma.

If a body at A, be impelled by two forces at the ſametime, the one in the A D, capable to cary that body from A to B, in a certain ſpace of time; and the other in the direction A D, capable to cary it from A to D, in the ſametime; complete the parallogram ABCD, and draw the diagonal A C, then the body at A, agitated by the two forces together. will move along the line A C, and will be in the point C at the end of the time in which it would have moved along A B. or A D, with the forces ſeparately applid, hence will ſolutions to the following examples be evident.

A General method to find the motion of a current, has often been practiſed in the Weſt India voyages is thus,

When

When there is a ſmooth ſea and no wind, heave out your boat, and take into her three or four men, with a compaſs, a log line, a large pot, and a half minute glaſs, alſo a quoil of inch rope, (when you are a little diſtance from the ſhip) which faſten to the bool of the large kettle, or great iron pot, caſt it over board, letting it ſink at leaſt 80, 100, or 120 fathoms, the more the better. then belaying the rope about the boats ſtem it will bring her up, and maſte her ride as if at anchor, heave your log, and turn up your half minute glaſs, as you do in the ſhip to find your diſtance run, as you veer out the log line, ſet the drift of the log by the comaſs, ſo ſhall you know if there be any current or not, and if any, how it ſets, as ſuppoſe you find the current ſets eaſt one knot and a half, in half a minute, then is the motion of the current eaſt 36 miles in 24 hours, but you muſt obſerve firſt to allow the variation of the compaſs, by the rules before given.

If the rope be 80 fathoms allow a quarter part, of 100fathoms a fifth part &c, of the drift of the current, more for the drift of the boat, for though the boat ſeems to ride or lie ſtill, yet ſhe is found by experience to drive at the ſametime. Having by this experiment found the quantity and quality of the current, the ſhips true motion may be obtained by the following problems or queſtions.

Queſtion 1ſt. Suppoſe two ſhips ſails by the compaſs directly ſouth 140 miles in twenty four hours in a current that ſets E. 59 miles in ſame time, required the ſhip's true courſe and diſtance.

Geometrically Conſtructed.

Draw A B to repreſent the north and ſouth line of the ſhip at A, which make equal 140, from D, draw D C, perpendicular to A D equal 59 miles, and join A C, then C will be the ſhip's true place, A C her true diſtance, and angle C A D her true courſe.

Trigonometrical Calculation.

As apparent diſtance A D	140	As S. courſe	22,51
Is to the current motion D C	59	Is to current motion	59
So is T. Radius	45,00	So is Radius	90,00
To the tan. courſe	22,51	To the true diſtance	151,9

Conſequently the ſhip's true courſe is S, 22,51 eaſterly, and her true diſtance equal 151,9 miles, as was required.

Queſtion 2d. ſuppoſe a ſhip ſails by the compaſs S. E, 166 miles, in twenty-four hours, in a current that ſets W. by N. five miles an hour, required the ſhip's true courſe and diſtance?

Geo-

Geometrical Conſtruction, Fig. III, Pl. 141.

Having drawn and quartered the circle as before directed, placing N E S W, at the ſeveral quarters, let A, repreſents the place the ſhip ſailed from, then draw the S E, line C A, which make 166, then will C, be the place the ſhip apparently arrived at, through C, draw the line C B, parallel to the W, by N, line A B 120 miles, the motion of the current in twenty-four hours, and join A B, then will be the ſhip's true place at the end of twenty-four hours; A B her true diſtance, and the angle S A B, her true courſe.

Trigonometrical Calculation.

In the oblique triangle A B C are given the the ſide C A equal 166, the ſide B C 120, and the angle A C B three points or 33 ,45, (the diſtance between S, E, and E, by S,) to find the angles A and B, and ſide A B.

A C	166	180 ,00	As Z, of ſides A C + B C 286
B C	120	33 ,45	Is to X of ſides A C — B C 46
Z. ſides	286	146 ,15	So is T. half Z. ∠ 73 ,07
X. ſides	46	73 ,07	To T. half X of angles 27 ,55
Half ſum of angles		73 ,07	As S angle A 45 ,00 fr. 45 ,12
Half difference of angles		27 ,55	Is to ſide B C 120 ſu. 45 ,00
Angle B		101, 02	So is S angle C 33 45
Angle A		45, 12	To the ſide A B 93 ,96 R. 00,12

Anſwer, The true courſe of the ſhip is S, 00 ,12 weſterly, and her diſtance made good 94 miles

Queſtion 3d, ſuppoſe a current ſets abaft the beam or quarter, or before the beam or bow, as ſuppoſe a ſhip ſails N, E, 198 miles, in twenty-four hours, and a current under foot, that ſets eaſt 100 miles, in the ſame time, I demand the courſe and diſtance made good by the ſhip.

Geometrical Conſtruction.

Draw A B, and project the triangle A B C, with the courſe N, E: 45 ,00, and diſtance 188 miles as in caſe firſt of plain ſailing, then ſet off the currents motion 100 miles from C to D, and draw the ſhip's true diſtance A D, then is C, the place of the ſhip without allowing for the current, and D, her true place, with allowing for it.

Trigonometrical Calculation,

In the right angled triangle ABC, find the difference of latitude and departure, without regarding the current thus,

As Radius	90 ,00	As Radius	90 ,00
Is to the diſtance	188	Is te the diſance	181
So is s, courſe	45 ,00	So is s, c, courſe	45 ,00
To the departure	133	To the diff. of lat.	133

Then 133—100 equal	233 = B D	As s, courſe	60 ,18
As diff. of lat.	133	Is to the departure	233
Is to tangent Radius	45 ,00	So is Radius	90 .00
So is the departure	233	To the diſtance	268,3
Te tan, courſe	60 ,18		

Anſwer, her true courſe is N 60 18 eaſterly or N E by E quarter E neareſt diſtance made good 268.3 as was required,

Queſtion 4th. Suppoſe a ſhip ſails N W 225 miles in 24 hours and a current under foot ſetting E S E 108 miles in the ſame time, required her courſe and diſtance made good.

Geometrical Conſtruction

Conſtruct the triangle A S C as in the foregoing queſtions with the courſe N W and the diſtance 225 miles make D C an E S E line equal 108 miles then is A D a N W line equal 43 00 and D C an E S E iine a 67 30 then make C E parallel to D B, and C F perpendicular to D E ſo ſhall the angle C A E repreſent the ſhip's true courſe and AC equal her diſtance made good.

Trigonometrical Calculation.

Firſt. In the obtique triangle A D C are given two ſides and an angle between them to find the other angles and the third ſide viz. ſide A D equal 225 ſide D C equal 108 miles and the angle A D C equal 2 points or 22 30.

B D	225	From	180 ,00	Half Z, angle	78 ,45
D C	108	Sub.	22 ,30	Half × of angles	60 ,29
Z ſides	333	Z, angles	157 ,30	Angle C	139 ,14
× ſides	117	Half Z, ∠s	78,45	Angle A equal	78 ,16

as

As sum of sides	333	As S. angle C A D	18,16
Is to difference of sides	117	Is to side C D	108
So is T. half sum of angles	78,45	So is S. angle C D A	23,30
To T. half × of angles	60,29	To the side A C	131,9

From 45,00	Hence her true course is N. 26,44 westerly, and
Subt. 78,26	distance made good 131,9 miles; find the difference
Rem. 26,44	of latitude and departure thus,

As Radius	90,00	As Radius	90,00
Is to the distance	117	Is to the distance	131,9
So is s, course	78,45	So is s. c, course	63,16
To the departure	59,32	To the diff. of lat.	117,8

Note, in all these examples where there is course or courses, and the distance sailed in 24 hours, and the setting and drift of the current in quantity and quality is given, in the same time the navigator need only put down the said course and drift of the current, among his other courses and distances by the log, when he works his traverse table, which is plain and easy, I think, without any example, as the student will find it appears by working the foregoing examples this way.

Case, 2d. Course and distance sailed, and course and distance made good being given to find the setting and drift of the current.

Question 5th. A ship sails by the compass and log N. 54,34 easterly 73 miles, and then arrives at a place which is known to bear from the place, sailed from NE 100 miles, (having been deceived by an unknown current) I demand which way the current sets, and how fast, supposing the ship sails by the log, 5 miles an hour.

Geometrical Construction. Fig. III, *Pl.* 141,

Make the angle D A B equal 54,34 and A B equal 73 minutes and let fall the perpendicular D B which will represent the departure and A D her difference of latitude by the course and distance by the log, after the same manner describe the triangle B A C, and upon B C, let fall the perpendicular E F, then is E C, the drift, and the angle F E C, the course of the current, and also the angle B A C, the ship's true course, and A C her distance made good, A B her difference of latitude, B C her departure made good.

Trigonometrical Calculation.

As Radius	90,00	As Radius	90,00
Is to the distance	73	Is to the distance	73
So is s, course	54,34	So is s, course	35,26
To the departure	59,7	To the diff. of lat.	42

Now having the course and distance made good, to find the difference of latitude and departure.

As Radius	90 ,00	Then having latitude 29, and departure 11 of current given.
Is to the distance	100	
So is 1. course	45 ,00	
To the departure	70 ,71	

Find the course and distance by the 6th, case of plain sailing.

As diff. of lat.	22	As 1, course	20 ,49
Is to tangent Radius	45 ,00	Is to the departure	11
So is the departure	11	So is Radius	90 ,00
To tan. course	20 ,49	To the distance	31

So that the current set N, 20 49 easterly 31 miles in the time that the ship sailed N E 100 miles, now if the ship sails 5 miles an hour, she will be 20 hours in sailing 100 miles, in which time the current sets 31 miles, therefore divide 31 by 20 and the quotient is 1,55 knots, or miles an hour, for the velocity of the current, as was required.

Case 3d. The course and distance between any two places, and the course and motion or velocity of a current that lies between them, given to find what course to steer by the compass, or how much to windward of your true course to steer; that so the compound motion of the ship, may just set her to her desired port.

Question 6th. Suppose a ship sails by the compass and leg from a certain port A to another at D bearing S W half W and N E half E of each other, distance 123 milet and a current under foot, setting one mile and a half an hour, I demand what course she must steer from the first port, and what distance by the log, she must run to arrive at the port D, allowing the ship's motion four miles and a half an hour.

The Geometrical Construction. Pl, III, Fig, 151

Having drawn the triangle A B C with the course N E half E or N 50 37 easterly and distance 123 miles then having found the difference of latitude and departure to the said compass course, if no current was accounted for, by the first case of plain sailing then if four miles and a half an hour, : 123 miles :: one mile mile and a half an hour : 41 miles the motion of the current in the time the ship is sailing from A to C then set off 41 from C to D and draw the line A D then is the angle B A D her true course which she must steer and A D her distance which will bring her to the port D.

Then in the oblique triangle A D C, here are two sides and an angle between

between them given, to find the other angles and the thirds ſide A D, viz. ſide B C equal 123, fine D C equal 41, and angle A C D 39 ,41.

A C	123	180 ,00			Half Z, ∠ 70 ,18
C D	41	39 ,23	As Z, of ſides 164		Half ✕ angles 54,26
			Is to ✕ of ſides 70		
Z.	164	140 ,37	So is T. ha, Z. ∠s 70,18		Angle D 124 ,44
			To T. ha. ✕ ∠s 54,26		
✕	82	70 ,18			Angle C 15 ,52

As S, angle D A C	16 ,52	From	50 ,37
Is to ſide D C	41	Sub.	19 ,52
So is S. ∠ A C D	39 ,23		
To the ſide D A	89,7	Remains	33 ,45

Hence the courſe which ſhe muſt ſteer is 34 45 weſterly and diſtance 89 7 miles willl bring her to the port at C as was required.

Queſtion 7th. Suppoſe a ſhip coming out from ſea in the night, has ſighi of Scilly light bearing N E by N, diſtance four leagues it being then flood-tide ſetting E N E two miles an hour and the ſhip running at the rate of five miles an hour, required upon what courſe and how far ſhe muſt ſail to hit the lizard which bears from Scilly E half S diſtance 17 leagues.

The Geometrical Conſtruction. Pl. 3. Fig. 151

Having drawn the ſemicircle N E S let A repreſent the ſhip's place at ſea, and draw the N E by N line A S which make equal 12 miles to S, which will repreſent Scilly, from S draw S L equal 51 miles, and parallel to an E half S line then L will repreſent the lizard, from L draw L C parallel to the E N E line equal two miles and from C draw C D equal 5 miles, meeting A L in D, then from A draw A B parallel to C D meeting L C produced in B which will be the required diſtance, and S A B the angle of the courſe.

Trigonometrical Calculation.

1. In the triangle A S L are given the ſide A S equal 12 miles ſide S L equal 51 and the angle A S L equal 118d 07m the diſtance between N E by N and W half N lines to find the angles S A L and S L A conſequently by caſe 4th, of oblique triangles it will be,

S. L.	51	180 ,00			half Z ∠ 30,86
A S.	12	118 ,07	As Z. ſides 63		half ✕ ∠ 20,21
			Is to ✕ ſides 39		
Z.	63	Z, 61 ,53	So is T. ha. Z. ∠s 30,56		∠ SAL 51 ,17
			To T. ha. ✕ ∠s 20,21		
✕	39	✕ 30 ,56			∠ ALS 10 ,35

Con

Conſequently the angle S A L 51 .17 4 33 .45 equal 85d 02m the bearing of the lizard from the ſhip then,

As S, angle SAL	51 ,17	Hence the diſtance between the Lizard and ſhip is 57,6 miles.
Is to ſide S L	51 m.	
So is S, angle ASL	61 .53	
To ſide A S	57 .6 m.	

2. In the A D L C are given the angle L equal 17 ,32 the diſtance between the E N E and N 5 ,02 E lines, the ſide L C equal two miles, the currents drift in an hour, and the ſide D C equal 5 miles, the ſhip's diſtance run in the ſame time to find the angle D thus.

As ſide B C	5 m.	Since by conſtruction the angle L D C, (the courſe the ſhip muſt ſteer) is S. 83,05 eaſtly, Then for the diſt. A B, it will be by caſe 2d. of oblique trigonometry.
Is to s angle L	17 .32	
So is L C	2 m.	
T S. angle D	6 .55	

In the oblique triangle A B L, are given the ſide A L equal 57 .6 angle B equal 155d 33m and the angle L 17d. 32m to find the ſide A B.

Angle L	17 .32		
Angle D	6 .50		
Sum	24 ,27	As S. angle B	155 ,33 (24 .27
Subſtract from	180 .00	Is to ſide A L	57,6 m.
Angle B	155 .33	So is S. angle L	17 ,32
		To the ſide A B	41 ,96

Conſequently as the ſhip is ſailing at the rate of five miles an hour, then 41 ,96 ÷ 5 equal 8,37, hours, 24 miles S, 83 ,05 eaſterly, ſhe will arrive at the Lizard.

Queſtion 8th, Suppoſe a ſhip from a certain headland in the latitude 34 ,00 N ſails S W by S 156 miles in 24 hours in a current, that ſets between the north and weſt, and the ſame headland is found to bear E N E and the ſhip is found to be in the latitude 32,49 N required the ſetting and drift of the current,

Geometrical Conſtruction. Pl. III. Fig. 148.

1. Having drawn the ſemicircle and put N S W and A at the center to repreſent the place of the ſhip, and draw the S, W, by S, line A B equal 156 miles, alſo the W S W line A F at pleaſure ſet 71 miles from A to F on the meridian A S draw F E parallel to the weſt line A W cutting the W S W line A B in E join E E with the right line then E will be the ſhip's place, angle A E E the ſetting of the current, from the ſouth

S E by S line and the line B F will be the drift of the current in 24 hours, to find which by,

Trigonometrical Calculation.

1. In the right angled △ A F E is given the difference of latitude A F equal 71 miles and the angle E A E equal 67 .30 by which we find the side A E the distance the ship has sailed.

As s. c, course	22,30	As Radius	90,00
Is to the diff. of lat.	71 m.	Is to the distance	185,7
So is Radius	90,00	So is s, course	67,30
To the distance	185,7m.	To the departure	171,4

Hence the ship's distance made good is 185,7 miles, and her departure 171,4.

2. In the oblique △ A B E there are two sides and an angle between them given, viz side A E equal 185,7 miles the side A B equal 156 miles and the angle E A B 5 points or 33,45 to find the angles E and B and side B E.

Side A E	185,7	From	180,00		
Side A B	156	Subt.	33,45		
Z. sides	341,7	Z angle	146 .15	As the sum of sides	341,7
diff. sides	29,7	half Z ∠s	73,07	Is to the diff. of sides	29,7
				So is T. ha. Z angles	73,07
				To T, half diff. of an.	15 .59

Half sum of angles	73 .07		
Half difference of angles	19,59	As s. angle A E B	57,08
Angle E B A	89,06	Is to side A B	156
Angle A E B	57,08	So is Sangle B A B	33 .45
		To the side E B	103,2

From	89,06	Answer, the current sets north 55,21 easterly, at the rate of 4,3 miles an hour.
Subtract	33,45	
Remains	10,32	

Question 9th. Suppose a ship sails from a certain headland and by the log in 24 hours runneth N. N. E. 120 miles in a current setting between the south and east, and then they understood the cape bore from them W S W and by observation, the ship's difference of latitude was 75 miles I demand the currents motion, that is upon what point of the compass and how fast,

Ge-

Geometrical Conſtruction

After the circle is deſcribed and quartered, lay two points from N, towards E, and draw the N. N. E. line A C equal 120.

2. Lay 6 points from N towards E and by it and A draw an E N E line A D at pleaſure then lay 75 miles on the meridian from A to F and draw the line F D parallel to A E to cut the line A D in D then draw a line from D to C and the conſtruction is done, for the angle A C D being meaſured on the ſcale of chords ſheweth the currents motion and the ſide C D ſheweth how faſt.

Trigonometrical Calculation.

1. In the right angled Δ A F D i given the ſide A F equal 75 and the angle F A D equal 67 ,30 and the angle F D A equal 22 ,30 to find the ſide A D thus,

As the s. F D A	22 30	As Radius	90 ,00
Is to ſide F A	75 m.	Is to ſide A D	196 m.
So is Radius	90 ,00	So is s. angle F A D	67.30
To the ſide A D	196 m.	To the ſide F D	181,1

2. In the oblique Δ A C D there are now the ſide A C equal 150 ſide A D 196 and the angle C A D contained between them 4 points or 45 00 to find the angle A C D the currents motion to the ſouth eaſtward, and the ſide C D its velocity.

AD + AC equal 346 equal Z ſides
AD — AC equal 46 equal X ſides

180 .00	Half Z angles	67 ,30
45 .00	Half dif. angles	17 ,48
135 .00	Angle ACD	85 .18
67 ,30	Angle CDA	49 .42

As ſum of ſides	346
Is to diff. of ſides	46
So is T. half Z angles	67,30
To T. half diff. angs.	17,48
As s. angle C A D	49 ,42
Is to ſide A C	150
So is s. angle C A D	45 .00
To the ſide C D	139

Angle C	85 .18
Subt.	22 ,30
Rem.	62 .48

Anſwer, The current ſets ſouth 62 .48 eaſterly, Diſtance 139 miles in 180, or at the rate of 5,8 miles an hour.

Of

Of Turning to WINDWARD in a CURRANTS.

THIS may alſo be divided into ſeveral caſes, of which I ſhall ſpeak, in order, but that which is chiefly uſeful, is when the courſe and motion of the current is given with the courſe and diſtance between the place ſailed from, and the place bound for, and from what place the wind blows, and how near the wind the ſhid will make her way good, for thoſe four things are commonly given, or known, to find how long ſhe muſt lie upon each taek, to gain her port, ſuppoſing her rate of running, or miles ſailed in an hour by the log, be alſo given or known.

Queſtion 1ſt, ſuppoſe two ports bear north and ſouth of each other diſtant 270 miles. the wind at ſouth, and a current ſets ſouth, two miles an hour, a ſhip is bound directly to windward to the ſouthermoſt port and can lie within 72, 00 off the wind. gets her ſtarboard tack aboard, and ſails ſix miles an hour by the log I demand how long ſhe muſt lie upon each tack to gain the port and what courſe ſhe makes good.

Geometrical Conſtruction. Pl. III, Fig, 152

1, Draw the meridian or north and ſouth line A B which make 270 miles and the angle A B C or B A C equal 72 00 equal the ſhip's courſe from the wind, then biſect A B in D and draw B C perpendicular to A B biſect A C in C and K E parallel A D cutting D C in E the place the ſhip tack'd then A C and B C are the diſtance ſailed at each tack, without regarding the current, which diſtances is thus found by meaſuring the diſtance A C or B C on the ſame ſcale, that A B was taken from. will give 436 miles for her diſtance upon each tack.

By Trigonometry thus,

Then As s. angle ACD	18,00
Is to ſide A D	135
So is Radius	90,00
To ſide AC or BC	436

The diſtance upon each tack is 436 miles, to gain the deſired port, if there had been no current, which 436 divided by 6 miles ſailed in an hour quotes 72,6 hours in which the ſhip ſails from A to C but the current ſets ſouth 2 miles an hour which makes 145,2 ſouth in 72,6 hours therefore draw the ſouth line C G equal 145,2 miles end alſo A G which will repreſent the compound motion of the ſhip or courſe made good, but becauſe ſhe is to lie upon that tack, but only till ſhe be got half way to the intended port, obſerve where the line A G cuts the perpendicular D C as in E, draw A E and B E ſo ſhall A E be the diſtance on the ſtarboard, and B E the diſtance on the larboard tack to obtain the port B and the angle D A E the courſe made good, by the reaſon of the current but to find how far the ſhip muſt

must ſail by the log, in the time ſhip will be at E by the help of the current draw E K parallel to G C this parallel will cut A C proportionably by (2 E 3) viz. A G : A E : : A c : A K the diſtance by the log (which is found by the following calculation) 210 ,3 this divided by 6 the miles ſailed by the log in an hour, gives 35 ,05 hours 12 ,35 hours 3 minutes, the time to ſtand upon the ſtarboard tack, and the ſame time upon the larboard tack to fall in with the port bound for at B.

Trigonometrical Calculation.

ℸ 2. In the oblique triangle A C G there is given the ſide C G equal 145.2 the ſide A C equal 436 miles with the angle A C G contained between them equal 108 00 (for C A is a line W 18 0 northerly and C G is a ſouth line) and from W 18 ,00 northerly to ſouth is 108 ,00 to find the angle C A G and ſide A G.

Side AC	439	180 ,00
Side CG	145	108 ,00
Z ſide	581,2	72 ,00
diff. ſides	290,8	36 .00

As Z ſides AC + CG	581,2
Is to diff. ſide AC — CG	290,8
So is Γ, half ſum' angles	36 ,00
To T. half ✕ of angles	19 .59

ℸ Hence the D A C equal B A C and 72 ,00 angle C A G equal 16 01 remains 55 59 equal angle D A E whoſe complement to 90 00 equal 34.01 equal angle A B D as may be ſeen in the figures annexed, then to find the diſtance made good upon each tack.

Half ſum of angles	36 .00
Half diff. of angles	19 ,54
Angle AGC	55 ,59
Angle C A G	16 01

As S. angle AED	34 ,01
Is to ſide A D	135 m.
So is Radius	60 ,00
To the ſide AE	241,3

The diſtance made good upon each tack equal 241 .3 miles then to find the diſtance, ſailed by the log A K which by the help of the current ſhe is carried to E, then in the oblique △ A K E is given A E equal 241,3 and ∠ A K E equal ∠ A G C 108 .00 alſo the angle C A C equal 16 .01 and angle A E K equal A C C equal angle D A E equal 35 56 viz all the angles and oppoſite ſide A E to find the other oppoſite ſide by caſe 1ſt. oblique ſailing.

As S. angle AKE 108 ,00	(72 ,00
Is to ſide AE	241,3
So is S. angle AEK	55 .59
To ſide AK	210,3

Hence the diſtance ſailed by the the Log is 210,3 miles, divided by 6, gives 35 ,03 hours, or 35 hours 3 min.

The

The time ſhe muſt lye upon the ſtarboard tack in which time ſhe is carried by the current from A to E, and then lying ſame way upon her larboard, ſhe will arrive at her intended port B, ſo that in ſeventy hours ſix minutes, ſhe performs the voyage of 270 miles, alt ough upon a wind, by the help of the current, which if their had been no current, would have required 162 hours, at the ſame rate of ſailing.

Caſe ſecond, When the current ſets obliquely, that is, neither north, ſouth, eaſt, or weſt, and the port bound to, is upon any other point, and not on the afore ſaid four cardinals.

Queſtion 2d, Suppoſe a ſhip makes her way good within ſix points or 73 ,07 from the wind, being bound to a point at P, bearing from A, S. W. by S. one quarter W; diſtant 476 miles, in the time that the ſhip ſails 300 miles; I demand the courſe and diſtance the ſhip muſt ſail upon her ſtarboard tack A D, and what upon her larboard D P, to gain the ſaid port at P.

Geometrical Conſtruction. Pl. III, Fig, 152

Having drawn a ſemi circle, and ordered it as before ſhown, placing W S E, ſet off one point from s to W, for the wind line, and A *e* for the currents motion, being a S. by E, line, then ſet three points and a quarter from s towards w, and draw a S. W. by S. a quarter W. line, and make A P thereon 476 miles, or 158 leagues, the diſtance of the port P, then ſet off ſix points and a half, or 73 ,07 from the wind line both ways to B and F, and draw A B, and B E, which is her ſtarboard and larboard tacks without a current, make A F and B D, each 300 miles, or 100 leagues, and from B and F. draw parallels to A E, the line of the currents motion, and make B C and F G, each equal to 110 miles, or 36,2 leagues, and draw A C and A G, ſo ſhall C and G, be the place of the ſhip on either tack, with allowance for the current,

Then ſuppoſe the ſhip gets her ſtarboard tacks on board at her firſt ſetting out, then draw from P, a line parallel to A C, to cut A G in D, the place where the ſhip muſt tack, ſo ſhall A D be her true diſtance on her ſtarboard, and DP her diſtance on her larboord tack, to gain her deſired port P,

Trigonometrical Calculation.

1ſt. In the oblique triangle A G F, we have given A E equal 300 miles, F G 110 miles, and the angle A F G equal 11 points and a half, equal 129 ,22, for E A is a N. W. by W. half W. line, and F G a S. by E. line, from the one to the other is 11 points and a half, to find the angles A and G, and ſide A G. Therefore by caſe third, oblique trigonometry.

Side A B	303	From	180,00		
Side P 6	110	Subt.	129,22	As the sum of sides	410
				Is to the diff. of sides	190
Z sides	410	Z. ∠s	50,38	So is T. half Z angles	25,19
				To the T. half diff. angles	12,21
× of sides	190	× ∠	25,19		

Half Z angles	25,19	From five points and a half	61,52
Half dif. angles	12,21	Take angle FAG	12,58
Angle AGE	37.40	Remains arch S D	48.54
		Add three points and a half	36,34
Angle FAG	12.58	Sum is angle PAD	85,28

3d. In the oblique triangle ABC, we have given the side AB equal 300 miles, or 100 leagues, BC 110 miles or 36,1 leagues, and the angle ABC seven points and a half equal 84,22, for the line B A is an E. half N. and BC a S. by E. line, from S. by E. to E. half N. is seven points and a half, or 84,22; to find the other angles and the third side.

Side AB	300	180,00			
Side BC	110	84,22		As the sum of sides A B + B C	410
				Is to the difference A B — B C	190
Z. sides	410	95,38		So is T. half sum angles	47,49
				To the T. half × angles	27,05
× sides	190	47,49			

Half sum of angles	47,49		
Half difference of angles	27,05	From	84,22
		Subtract	20,44
Angle BCA	74,54	Remains	63,38
Angle BAC	20,44		

Whence the arch S C, south 63,38 W. so that the line CA or its parallel P D, is N. 63,38 easterly, and the line P A is N.E. by N. 1 qur. E. equal N. 36,34 easterly, their difference or the angle contained between them is 27,04 for the angle A P D.

Also the line D A is N. 48,55 westerly, and the line PD parallel to C A is S. 68.53 westerly, the angle between these two 67,27 equal angle A D P, viz. 48,55 + 63,38 equal 112,33, and 180,00 — 112,33 equal 67,27; so we have now given, in the oblique triangle APD the angle A equal 85,28, angle P equal 27,04 and angle D equal 67,27, and its opposite side A P equal 476 miles; to find the other sides A D and D P, as followeth.

As

As s. angle D	67 ,25	As the S. angle D	67 ,25
Is to ſide A P	476 m.	Is to ſide A P	467
So is s. angle A	85 ,28	So is S. angle P	27 ,04
To the ſide D P	514 m.	To the ſide A D	234,5

Conſequently ſhe made 234,5 miles diſtance on her ſtarboard tack, and 514 miles diſtance on her larboard tack, ſo that with allowance for the current the ſhip muſt ſail S. 48 ,55 eaſterly, 234,5 miles, and S. 63 38 weſterly 514 miles, to gain the intended port P. WWR.

Queſtion 3d. A maſter of a ſhip having taken a freight from an iſland at A, to another iſland at B, and having his ſon on board along with him to gain experience, he enquires of his father whether there was not a current ſetting upon ſome point between the two iſlands; his father refuſing to tell him, but bids him obſerve well the dead reckoning outward bound and alſo home, and ſee if he could not by comparing them find the courſe and motion of the current; where upon the Captain who knew very well what way the current ſet, and how the iſlands bore of each other, cauſed them to ſteer away ſouth, and in running 270 miles upon that courſe, they arrived at B, and having done their buſineſs there, they ſteered N. W. and running 380 miles upon that courſe, they arrived at A; Now I demand how the iſlands bore from each other and how far diſtant, alſo which way the current ſets, and how faſt, ſuppoſing the ſhip ſailed always at the rate of five miles an hour by the log.

The Geometrical Conſtruction. Pl. 3. Fig. 151

Draw the north and ſouth line A C equal 270 miles, the firſt courſe and diſtance, then by reaſon her courſe home was now N. W. to A, draw the line A D at an angle of 45 ,00 from A C, becauſe if D A be N, W. then A D muſt be S. E, and conſequently make an angle of 45 ,00 degrees, with the line A C, and ſet of 380 miles, from A to D, and draw the line C D, which repreſents the motion of the current, during the ſhip's ſailing from A to C, and from D to A, for the finding of which you have given the ſide A C equal 270 miles, the ſide A D 380, and the contained angle C A D 45 ,00, to find the angle A C D, by caſe 4th of oblique trigonometry.

Side A C	270	180 ,00		
Side A D	380	45 ,00	As ſum ſides A D + A C	650
Z. ſides	650	135 ,00	Is to ✕ of ſides A D — A C	110
✕ ſides	110	Half ✕ 67 ,30	So is T. half Z. angles	67 ,30
			To T. half ✕ of angles	22 ,14

Half sum of angles	67 ,30
Half difference of angles	22 ,14
Angle A C D	89 ,44
Angle A D C	44 ,12

As S. angle A C D	89 ,44
Is to side A D	380 m.
So is S. angle C A D	45 ,00
To the side C D	268,7 m.

Here 268,7 is the current motion or course, during the whole voyage, now to find the bearing and distance of the islands, we see that in the whole voyage outwards and homewards, the ship runs 260 miles, which at five miles an hour, requires 130 hours, in which time the currents set 268,7, but her voyage outward being but 270 miles, which at five miles an hour requires but 54 hours; therefore say, by the rule of three, If in 130 hours the current sets 268,7 miles, how far will it set in 54 hours; viz, 130 : 268,7 : : 54 : 111,6, hence the currents race which the shiptails by the log from A to C is 111,6 miles, which set upon the line C D, from C to B, and draw A B, which represents the true course and distance between the two islands, for the finding of which by calculation, there is given, in the △ ABC. the side AC equal 270, the side C B 111,6, and the contained angle A C B equal 89 ,44, to find the other angles and side A B, as before directed.

Side A C 270	180 ,00	
Side B C 111,6	89 ,44	
Z. sides 381,6	90 ,16	
× sides 158,4	45 ,08	

As sum sides A C + B C	381,6
Is to difference of sides A C — B C	158,4
So is tangent half sum of angles	45 ,08
To tang. half difference of angles	22 ,39

Half sum of angles	45 ,08
Half difference of angles	22 ,39
Angle A B C	67 ,47
Angle C A B	22 ,29

Then for the side A D, the true distance the island, say,

As S. angle C A B	22 ,29
Is to side C B	111,6 m
So is S. angle A C D	89 ,44
To the side A D	291,9

Distance of the islands 291,9 miles.

Hence the angle C A B 22 ,29, the true course from A to B south easterly, which is S. S. E. one mile southerly, and the true distance between the two islands is 291,9 miles, the angle A C D, is the course of the current, found by the operation equal 89 .44 from the north. easterly, which is east 15 miles northerly, and for the rate or motion of the current's running. it is found by dividing the whole race of the current 268,7, by the whole number of hours the ship was under sail equal 130, the quotient (2,067) is the miles that the current sets in an hour, or appears by the operation, ——— 130)268,7(2,067 miles——— Hence in answer to what was demanded the course from A to B, is S. S. E. 01 miles southerly, the distance 291,9 miles, the course of the current

current is E. 0 ,16 northerly, and its rate or motion is 2.067 miles an hour; now for those that would prove the truth of the operation, they may easily do it by inverting the question, and state by the first case in current sailing, which the young navigator may try at his pleasure.

Question 4th. Admit a ship in still water with a certain sail carried, makes her way good with a seven point of the wind, being bound to a port bearing N. N. E. distant 100 miles, the wind being directly N. N. E. and a current under foot setting N. by W. 45 miles, the same time the ship sails by the log 55 m.; I demand the course and distance made good during the experiment, and her course and distance by the log on each tack.

Geometrical Construction. Fig. III, *Pl.* 141,

Draw a circle with the chord of 60 and quarter it with N E W S, and A at the center, to represent the place sailed from, then draw the N. N. E. line, and make A P equal 100 miles, then P represents the port bound to, then set off 7 points on each side of the wind line, and draw A B and A F, making each 55 the distance sailed by the log, during the experiment, and because the current sets N. by W, draw the N. by W. line, and through F and B, draw the lines E G and B C, parallel thereto, making each 45 miles the distance, set by the current, during the experiment, and draw G A and C A, which constitutes the oblique triangles A F G, and A B C, then in the oblique triangle A F G, are given the side A F equal 55, F G equal 45, and angle F equal 135 ,00, to find the angle F A G, and side A G, the distance made good, on the starboard tack during the experiment.

A F 55	From	180 ,00	
E G 45	Subtract	13, ,00	As sum sides AF + FG 100 m.
			Is to × sides AF — FG 10 m.
Z. sides 100	Remains	45 ,00	So is T. half sums ∠s 22 ,30
			To T. half × of ∠s 2 ,22
× sides 10	Half s. ∠	22 ,30	

Half sum of angles	22 ,30	
Half difference of angles	2 ,22	As s. GAF 20 ,08
		Is to side GF 45 m.
Angle AGF	24 ,52	So is s. angle AFG 45 ,00
		To the side AG 92 ,44 m.
Angle GAF	20 ,08	

Now AF being a N W by W. line, is therefore distant three points from west, to which if we add the angle GAF equal 20 ,08, the sum is 53 .53, the distance of the rhumb AG from the west towards the north, which subtracted from 90 ,00, leaves 36 ,00 from the north towards the west, which is N. W. by N, 2 ,26 westerly, and such course the ship makes her way good upon with her starboard tacks on board.

2d. In the oblique triangle ABC, are given the ſides AB 55 miles, BC equal 45 miles, and the ∠ ABC equal 67 ,30, to find the ∠ BAC, and the ſide AC her diſtance, with the larboard tack on board.

AB	55	180 ,00	
BC	45	67 ,30	As ſum of AB + BC 100
Z. ſides	100	112 ,30	Is to difference of ſides AB + BC 10
			So is T. half ſum of angles 56 ,15
X ſides	10	H. Z. 56 ,15	To T. half difference of angles 8,31

Half ſum of angles	56 ,15		
Half difference of angles	8 ,31	As s, angle BAC	47 ,44
		Is to the ſide BC	45
Angle ACB	64 ,46	So is s, angle ABC	67 ,30
		To the ſide AC	56 ,18 m.
Angle BAC	47 ,44		

Now AB being an E, by s. line, if we ſubtract the angle EAB equal one point or 11 ,15, from 47 ,44 there remains 36 ,29 the diſtance of the rhumb line AC from the eaſt towards the north, which therefore take from 90 ,00, and there remains 53 ,31 the diſtance from north towards eaſt, which is therefore N. E. 3 quarters 5 ,05 eaſterly, and ſuch courſe the ſhip makes her way good with her larboard tack on board.

For the diſtance the ſhip makes good to gain the port, the Operation.

From the point P the port, draw a line as PD, parallel to AG, cutting AC produced in D, which conſtitutes the triangle ADP, then if the ſhip firſt ſets ſail with her larboard tacks on board, ſhe ſailed from A to D, and then hauled up and tacked about and ſailed on DP with her ſtarboard tacks on board, to gain the port P, therefore in this triangle, we may determine the diſtance made good upon each tack, arithmetically, as was taught in the foregoing problems, if the parallel had been drawn on the other ſide it would form the triangle LAP, ſimilar and equal to ADP, and the calculation is the ſame in both triangles and you have AD equal DP 51 ,53 miles, the diſtance on the ſtarboard tack, and AD equal IP 15 ,22 miles, the diſtance on the larboard tack, found by the following proportions.

As s. angle ADP	89 ,28	As s. angle ADP	89 ,28
Is to ſide AP	100 m	Is to ſide AP	100 m.
So is s. angle APD	58 ,27	So is s. angle PAD	31 ,61
To the ſide AD	85 ,22 m.	To the ſide PD	51 ,53 m.
Diſtance on the larboard tack.		Diſtance on the ſtarboard tack.	

Having

Having drawn from the point L the line DK, parallel to GB, and it forms the Δ AKL, ſimilar to A F G in which A FG in which AK repreſents the diſtance ſailed by thd log, with her ſtarboard tacks on board, therefore as AG : A F : : AL : AK. that is 92,4 : 55 : : 51 ,53 : 30 6; miles, and drawing DH parallel to CB, you have this proportion, as AC : AB : : AD : AH, that is 56,18 : 55 : : 85 ,22 : 83 ,45, ſo that the ſhip ought to to ſail 30 ,65 miles by the log with her ſtarboard, and 83 ,45 miles with her larboard tack, to gain the port.

Corollary 1ſt. Hence it appears, that if ſhe firſt ſets ſail with her larboard tacks on board; ſhe will gain the port with her ſtarboard tacks on board, and the contrary if ſhe firſt ſet ſail with her ſtarboard tacks on board, ſhe will gain the port with her larboard tacks on board, and in both caſes ſailed the ſame number of miles.

Geographical Definition.

1ſt. The earth on which we dwell together, with the water, make one round body or globe, which is the ſubject of Geography.

2d. The poles of the earth are two imaginary points, directly oppoſite upon the ſurface of it; that in the north, called the north pole, and that in the ſouth, called the ſouth pole.

3d. The equator, or line under the equinoxial, is a line drawn round the globe, and lieth in the middle between both poles, and cutteth all meridians at right angles, and is a great circle, from which latitude taketh its beginning, and in which longitude is reckoned.

4th. Meridians are great circles, drawn through both poles, cutting the equator at right angles as P Q K, P A I, and PML, anſwerable to them, are the north and ſouth lines drawn in any chart.

5th. Parallels of latitude are leſſer circles, drawn parallel to the equator, through every degree and minute of the meridian, between the equator and each pole, as *att*, and Z ſun *tt*, and are repreſented in any charts by the eaſt and weſt lines therein.

6th. Latitude is an arch of a meridian contained between any parallel, and the equinox or equator from whence it is counted both ways to each pole, where it ends in 90, which is the greateſt latitude,

7th. North latitude is on that ſide of the equinoxial towards the north pole, and ſouth latitude towards the ſouth pole.

8th.

8th, Difference of latitude is an arch of the meridian, and is the neareſt diſtance between any two parallels, and ſheweth how far any place is to the northward or ſouthward of another place, and never exdeedeth 180 ,00.

9th. Longitude is reckoned in the equator, round which increaſing to the eaſtward, is counted by ſome, till it ends where it firſt began, in 360 degrees, which is the greateſt longitude, or according to Mr. Wakely, in his Mariners Compaſs rectified, it is counted from the meridian of London, increaſing on both ſides of it, both eaſtward and weſtward, till it terminates in 180 degrees.

10th. Longitude of a place, is an arch of the equator, contained between the meridian of that place, and the firſt meridian where longitude taketh its beginning (counted by the old way) to the eaſtward of the meridian, but by the new way it is counted both eaſtward and weſtward from the meridian of London, which in this account is the meridian, whence longitude taketh its beginning.

11th. Difference of longitude is an arch of the equator contained between the meridians of any two places, and never exceedeth 180 d.

12th. The difference of any two places, is an arch of a great circle paſing through them, and never exceedeth 180 degrees.

13th Here obſerve that the figure ſhews the projection of the terreſtrial globe on the plane of the meridian of London; in finding the diſtance of places there are three caſes, firſt, when the differ only in latitude, 2d. when they differ only in longitude, 3d. differing both in latitude and longitude, all which are performed by the following problems.

Geographical Problems.

Prob. 1ſt. Two places differing only in Latitude, to find their diſtance.

Note, two places under one meridian, or bearing north and ſouth from each other, or in one longitude, are ſaid to differ only in latitude.

2d. Two places differing only in Latitude, the difference of Latitude is the diſtance required, in which there are two variations; Firſt two places both on the ſame ſide of the equator, viz. both in north or both in ſouth Latitude, to find their diſtance.

Rule, Subſtract the leſſer Latitude from the greater the remainder reduced into leagues or miles, is the diſtance required.

Vari

Variety 2d. If one place be on one ſide of the equator, and the other on the other, viz. one in north latitude and the other in ſouth latitude, to find their diſtance.

Rule, Add the two given latitudes together, and the ſum reduced into leagues or miles, is the diſtance required.

There are ſo eaſy its needleſs to give examples, being the very ſame as is uſed in the plain and mercators charts.

Prob. 2d, Two places differing only in longitude, given to find their diſtance.

Note, Two places differing only in longitude, lyeing due eaſt and weſt from each other, and in one parallel of latitude, or otherwiſe under the equator.

In this Problem are two Varieties.

Variety 1ſt. Two places under the equator, their longitude being given, to find their diſtance.

If longitudes be eaſt or both weſt, ſubſtract the leſſer from the greater, the remainder is their diſtance, but where one is eaſt and the other weſt, add them together, and the ſum if it exceed not 180 degrees, is their diſtance; and when it doth exceed 180 degrees ſubſtract it from 360 ,00 the remainder is their diſtance required, which is the ſame as before ſhewn, in mercator ſailing.

Variety 2d. Two places under one parallel or both in the ſame latitude, their longitude being given to find their diſtance.

Example. I deſire to know the diſtance between the Lizard in England, and Penguin iſland, in Newfoundland,

Penguin iſland in Longitude	53 ,10 Weſt
Lizard in Longitude	5 ,24 Weſt
Remainder is the difference of Longitude	47 ,46
Both places in Latitude 50 ,00 N, whoſe complement is	40 ,00

Geometrical Conſtruction. Pl. III, Fig, 152

Draw the circle Æ P Q L, with a chord of 60 degrees, or half tangent of 90 ,00, and quarter it with two diameters or right circles, as PAL, and ÆAQ, then is P equal north pole, and I the ſouth pole, then with the ſecant of 47 ,46, the difference of longitude, draw the oblique circle PONI,

3d, Make Æ Z equal the given latitude, then with tangent of its complement, draw the parallel circle ZO *bt*, to cut the former oblique circle in O. then is O the Lizard, and Z equal Penguin iſland, both in one parallel of latitude. (4th) Having drawn the right circle ZAC, you have three points Z *bc*, through which to deſcribe an oblique circle is required, which completes the triangle PZO.

To find the diſtance by Trigonometry, it is to be noted that the Oblique Triangle is ZPO.

1ſt, Z P equal P O equal the complement of latitude 40 ,00 degrees.

2d. Angle ZPO equal the difference of longitude 47 ,46 degrees.

3d. Z O equal the diſtance of the two places, which to find let fall the perpendicular PB, by drawing an oblique circle with the ſecant of 23 ,53 equal half the given difference of longitude, to cut the oblique circle Z O in B, and ſo divides the oblique triangle into two right angled triangles PBO, and PBZ, in each the hypothenuſe, and one angle is given.

Then the angle ZPB, equal ZPO half ✕ of longitude, and ZB, equal BO half diſtance required, therefore the proportion is,

As Radius	90 ,00	10,
Is to S. C. latitude	40 ,00	9,808068
So is S. ✕ of long.	23 ,53	9,607322
To the S. half diſt.	15 ,05	9,415390

Half diſtance	15 ,05
	2
Doubled	30 ,10
	60
Diſtance	1810 m. which was required.

Problem 3d. To find how many miles or minutes in a degree of the equator, make a degree of longitude in any parallel of latitude.

The proportion is, As Radius 90 ,00 : Is to 60 miles or minutes, : : ſo is the S. C. latitude: to the miles or minutes of the equator, ma- a degree of longitude as required.

Example. In the latitude 54 ,20 N. required how many miles makes a degree of longitude?

As Radius	90 ,00	10.
Is to S. Co. lat.	35 40	9,765720
So is	60 miles	1,y78151
To the mil. on the equator	34,98	1,543871

er 35 miles very near.

Inſtrumentally.

Extend from S. 90 ,00 to S. 35 40, that extent on the fine of numbers from 60, gives 35 miles.

Prob.

Problem 4th. Two places differing both in latitude and longiude, their latitudes and longitudes being given to find their diſtance,

Note, In this problem there are three Variations.

Variation 1ſt. One place in the equator or under the equinoxial, and the other towards either of the poles.

Example, I demand the diſtance between the Lizard in England, and the entring of the river of Amozons, their latitudes and longitudes being as followeth.

Lizard in latitude	50 ,00	And Longitudes	5 ,24 W.
Amazons river latitude	00 ,00		48 ,04 W.
Subtract × of latitude	50 ,00	× of longitude	42 ,40

Steriographical Projection.

The circle being deſcribed and quartered, make Æ Z, on the premitive circle equal 50 ,00, the latitude of the Lizard, (ſee the laſt figure) Then lay 42 ,40 on the right circle from Æ to N, from the half tangents, the contrary way accounting 90 to be 10, 80 to be 20, &c. Then through Z and N. draw the oblique circle N C, and its done, for Z N meaſured on the premitive circle, when reduced thereto by its poles is the diſtance required.

But to find the diſtance by Trigonometry, obſerve,

1ſt. The leg Z E, repreſents the latitude of the Lizard 50,

2d, The leg Æ N, equal the × of longitude between them 42 ,40.

3d. The hypothenuſe Z N, the diſtance required. Then,

As Radius	90 ,00
Is to S C. latitude	40 ,00
So is s. c. × long.	47 ,20
To S. C diſtance	28 ,13

Then 90 ,00 — 28 ,13 equal 61 ,47, and being reduced into miles, gives 3707 miles, the anſwer required.

Variation 2d, Two places being towards one of the poles, that is both in north latitude, or both in ſouth latitude, their latitudes and longitudes being given, to find their diſtance aſſunder.

Example. I demand the diſtance of the Lizard from the iſland Barbadoes?

Lizard in latitude 50 ,00 N,		Longitudes	5 ,24 W.
Barbadoes in latitude 13 ,00 N.			57 ,54 W.
Difference of lat.	37 ,00	× of Longitude	52 ,30

Stereographical Projection.

Having deſcribed the premitive circle and quartered it with two diameters as before directed, make the angle ÆPL 52 ,30 equal the given difference of longitude, by drawing the oblique circle P L I, with the ſecant thereof; alſo on the premitive circle make P Z 40 ,00 equal the complement latitude of the Lizard, and draw the parallel circle *a* L *l t*, 13 ,00, diſtant from the equinoxial, being the latitude of Barbadoes. with the tangent of its complement, to cut the former oblique circle in L, the point for Barqadoes; then through z L c, draw a circle which completes the triangle.

But by Trigonometry to find their Diſtance, obſerve.

1ſt. P Z, The complement of the Lizards latitude 40 ,00

2d. P L, The complement of Barbadoes latitude 77 ,00

3d. Z P L, Their difference of longitude 52 ,30

4th. Z L, Their diſtance required.

Trigonometrical Proportions.

As Radius : Is to S. C. of their difference of longitude : : So is T. C. of the greater latitude : To the tangent of a fourth arch, which being ſubſtracted from the complement of the leſſer latitude, when the difference of longitude is leſs than 90 ,00 degrees; but when more than 90 ,00 degrees, from its complement to 180 degrees, and the remainder is the reſidual arch; then ſecondly, As the S. C. of the fourth arch : : Is to S. C, of the reſidual arch : : So is the S. of the greater latitude : To the S. C. of the diſtance required.

As Radius	90 ,00	10,	From S. C. leſs lat.	77 ,00	
Is to S.C. × of long.	37,30	9,784447	Subſtract fourth arch	27 ,04	
So is T. C. lat.	40 ,00	9,923814	Rem. reſidual arch	49 ,56	
To T. fourth arch	27 ,04	9,708261			

		co. ar.	
As S. C. fourth arch	62 ,56	0,050377	90 ,00— 33 ,37 equal 36 ,23
Is to S. C. refi. arch	40 ,04	9,808669	and 56 ,23 equal 3353 m.
So is *S.* lat. Liz.	50 ,00	9,884254	the diſtance of the Lizard
			and Barbadoes.
To S. comp. Diſt.	33 ,37	9,534230	

Queſtion 2d, I demand the true diſtance between cape Clear and cape Henry.

Cape Clear is in latitude	51 ,10 N	Longitudes	10 ,30 W.
Cape Henry in latitude	37 ,00 N.		75 ,02 W.
Difference of latitude	14 ,10	× of longitudes	64 ,32

The ſterographic projection being the ſame as in the laſt queſtion.

Trigonometrical Proportions.

As Radius	90 ,00	As S. C. fourth arch	70 ,54
Is to S. C. × longitude	25 ,28	Is to refid. arcl.	56 .06
So is T. C. latitude	38 ,50	So is S. latitude	51 .10
To the T. fourth arch	19 ,06	To the S. C. diſtance	43 ,11
Subſtract from	53 ,00	Subſtract from	90 ,00
Rem. refi. arch	33 ,54	Remains Diſtance	46 ,49

then 46 49 × 60 equal 2809 miles 936, 1 third leagues,

Variety, 3d. Suppoſe two places, one in north latitude and the other in ſouth latitude, their latitudes and longitudes, given to find their diſtance.

Example 1ſt. I deſire to know the diſtance between cape Cod in New England, and cape Bona Eſperanza, or cape of Good Hope in Africa.

Cape Cod is in latitude	42 ,10 N,	Latitudes	67 ,45 W.
Cape of Good Hope in lat,	34 ,25 S.		17 ,10 E.
Difference of latitude	76 ,35	× of long.	84 ,55

The Stereographical Projection.

1ſt, the primitive circle being diſcribed and quartered (ſee the laſt figure) make the Æ P M equal 84deg. 55m by drawing the oblique circle P M I with the ſecant thereof, but here the ſecant is ſo large it is not eaſy to do, therefore in ſuch caſes lay it in the right circle, Æ M A Q the equator from Æ to M from the half tangents the contrary way, and laying a bow ſcrewed up, to the three points P M and L and draw

draw the oblique circle by it, on the primitive circle make P Z the complement of cape cods latitude with the chord thereof, and draw the parallel circle a D T at 34 25 diſtance from the equinoctial (being the latitude of the cape of good hope) diſtance from the right circle Æ A Q to cut the oblique circle PM in D are preſenting cape bona eſperanzo, laſtly through Z and D draw a great circle z d c, and its done for z d being reduced to the primitive circle, by its pole, is the diſtance required.

Trigonometrical Proportions.

By trigonometry, to find their diſtance, it is to be conſidered that in the oblique triangle Z PD there is given,

1. P z the complement of cape cods latitude 41 50.

2. P D the diſtance of cape bona eſperanzo, from the north pole or the latitude which is 124 25.

3. D P z their difference of longitude 14 55.

4 z D their diſtance required which is thus found.

Firſt As radius: is to the ſine complement of their difference of longitude:: ſo is the tangent complement of the given latitude: to the tangent of a 4th. arch then if the difference of longitude be leſs than 90 00 ſubtract the 4th arch out of the other given latitude added to 90 00 but if the difference of longitude be more than 90 00 from the complement thereof to 180 the remainder to the reſidual arch and then,

Secondly, As the complement of the fourth arch: Is to the S. complement of the reſidual arch:: ſo is the *S.* complement of the latitude firſt taken: To the ſine complement of the diſtance required.

The Proportions.

As Radius	90,00	10,	
Is to S.C. X of lon.	5,05	8,947456	
So is T. G. lat.	47,50	10,04 3023	
To T. of 4th. ar.	5,35	8,990479	

From ſide P D	124,25
Subſtract 4th arch	535
Remains	118,50
Subſtract	90,00
Remains reſi. arch,	28,50

As

As S. *C.* of 4th arch	84 ,25	9,997935	To	90 ,00
Is to reſidual arch	25 ,50	9,683284	Add	18 ,59
So is s. lat. cape Cod	42 ,10	9,826910		108 ,59
		19,510199		60
To s c z d their diſt.	18 ,59	9.512259	Or 6839 m the diſtance required	

GREAT CIRCLE SAILING.

Or the Doctrine of Spherical Trigonometry, applyed to ſailing by the arch of a Great Circle.

GREAT Circle ſailing, as it is the exacteſt, ſo it is the moſt difficult, and ſcarce poſſible for a ſhip to ſail by, yet it may be of great advantage to keep conveniently near it, eſpecially in a parallel or an eaſt an weſt courſe,

2d, Great circle ſailing is ſailing by, or upon a great circle, paſſing through or over two places,

3d. In Great circle ſailing there are but three caſes, viz. 1ſt, when he differ only latitude, 2d. when they differ only in longitude; and 3d when the differ both in latitude and longitude.

Caſe 1ſt. Two places differing only in latitude, their latitudes given to find their diſtance.

As before, ſubſtract the leſſer latitude from the greater, and the difference there of reduce into miles, or leagues is the diſtance required.

Caſe 2d. Two places differing only in longitude, their latitude and longitudes given, to find the diſtance in the arch of a great circle, and all that is requiſite in great circle ſailing.

This is the ſame with the ſecond problem, 3 and 4 in Geography before going as to find their diſtance.

2 Theſe places are either in the equator, or in one parallel and lie eaſt and weſt from each other, but their diſtance in that parallel is not

their

their neareſt diſtance, being a leſſer circle.

3. Their diſtance in this parallel hath been ſhewn fully in parallel ſailing, and their diſtance in the arch of a great circle is found by problem 4th, of geography, but the angles of poſition, made by the great circle, and its latitude and longitude at any aſſigned portion, together with the courſe and diſtance from any place ſo aſſigned in it, is our work now and is as followeth,

Caſe 2d, *Problem* 1, Suppoſe the lizard and Penguin Iſland, both in the latitude 50 00 north and their difference of longitude 47 46 (as before in problem 4th, in geography) I demand the angles of poſition, the great circles diſtance between them, the latitude of the arch at every five degrees of longitude, and the courſe and diſtance of each of them according to mercator.

This problem is deleinated by the directions in problem 4, of geography, and obſerve that in the oblique ſpheric triangle A P C, in figure 173, A repreſents the lizard, C Penguin Iſland P A equal P C the complement of their latitude, the angle A P C equal their difference of longitude the angle C A P equal A P C equal the angle of poſition at each place, laſtly the ſide A C the great circles diſtance between them.

Firſt for C A P or A C P' the angle of poſition the operation is, draw the perpendicular B P as was taught before, with half the angle C P A which divides the oblibue triangle A P C into two right angled triangles A B P and C B P in each the hypothenuſe and one angle is given, that is.

1. The hypothenuſe A P equal C P the complement latitude 40 00 2d the angle A P B equal B P C half the difference of longitude, 23 53 3d, the angle B A P or B C P the angle of poſition at each place 4th. the leg A B equal B C = half the great circles diſtance 5th the leg B P equal the archs greateſt latitude whece the proportions,

As radius	90 00	10,000000	
Is to S C latitude	50.00	9,884254	
So is t. h, dif, l,	23 53	9,646199	
To T C ∠ B A P the angle of poſition which ſubtract from		18,449,530453	
	90 00		
Remains ∠ of poſition	14 07		

As Radius	90 ,00	10,0000
Is to s, c, lat,	40 ,00	9,8081
So is ha, X lon.	23 ,53	9,6073
To the s, of half diſtance in the arch,	15 ,05	9,4154
Half diſtance	15 ,05	
Doubled	30 ,10	diſt, required

ſecondl

Secondly, To find the latitude by which the arch ſhall paſs at every five degrees, difference of longitude from A repreſenting the Lizard, or firſt part; Theſe things following muſt be carefully obſerved. Firſt find the leg B P, the complement of the greateſt latitude, by which the arch of a great circle doth paſs, which is found by the following proportion.

As Radius	90 ,00	10,
Is to S.C. half × lon.	66,07	9,96112
So is T. C. lat.	40 ,00	9,92381
To T. C. B P,	37 ,30	9,88493
Sub. from	90 ,00	
Rem. the arch,	52 ,30	the Gr. lat.

Secondly, to find the lat. by which the arch of a great circle paſſeth at every 5 deg. of lon. from A, draw meridians from P, as P *d*, P *e*, P *f*, &c. which may eaſily be done gnomenically, being then ſtreight lines, thus,

Gnomenical Projection.

1ſt. Make angle A P C equal 47 ,46, the difference of longitude between the two places, then make P A and P C, each equal to the tangent of forty degrees the complement of the given latitude, and draw the line A C, which repreſents the arch of a great circle between them, and let fall the perpendicular P B, which being meaſured on the ſame ſcale of tangents, ſhews 37 ,30, the complement of the arch's greateſt latitude; then draw lines from P, each five degrees diſtance from each other, as P *a*, P *d*, P *c*, P *f*, P *g*, P *b*, P *i*, P *k*, P *l*, P *m*, which are meridians, and each 3 degrees of longitude from A, the Lizard, then meaſure P *d*, P *c*, P *f*, &c. on the ſame ſcale of tangents and it ſhews the complements of the latitudes of the arch at their reſpective places *d c f*, &c.

Theſe are found by ſpherical trigonometry, after this way you may draw ſeveral prick'd lines as P *b*, P *f*, &c. which are ſo many hypothenuſes in the rectangular triangles, which have one common ſide B P, the tangent of the arches greateſt latitude; now in each of theſe rectangular triangles, there is given a ſide and its adjacent angle to find the hypothenuſe, viz. in the triangle *d* B P, their is given the leg *d* B and angle P B *d*, to find P *d*, and ſo of all the reſt; ſo that the ſeveral angles *d* P B, *e* P B, *f* P, B &c. are found by continual ſubſtraction of five degrees from the angle A P B 23 ,53, half the difference of longitude, till this remainder be leſs then five degrees, which being taken out of five degrees, and to theſe laſt remainder add five degrees ſucceſſively, till the ſum exceed not 23 ,53, That is,

From the angle APB	23 ,53		The angle BP*b*		1 ,07
Sub. the angle APd	5 ,00		Add angle *b*P1		5 ,00
The remainders are	18 ,53	BPd	Their sum is the ∠s	BPg	6 ,07
	13 ,53	BPC		BP*b*	11 ,07
	8 ,53	BP*f*		BL*i*	16 ,07
	3 ,53	BP*g*		BPm	21 ,07
Which sub. from	5 ,00				
Remains the ∠ BP*b*	1 ,07		These angles are generally called vertical angles.		

Then to find the several latitudes of the arch, the proportion is this, As Radius, : Is to the fine complement of the vertical angle : So is the tangent of the arches greateſt latitude : To the tangent of the arches latitude required. Or thus by Gunter's ſcale.

Extend from s. 90 ,00 to s. 71 ,07. will reach from tangent 52 ,30 to tangent 50 ,53. and ſo on for all the reſt,

But by logarithms it may be contracted thus, ſeeing the firſt and third terms in each proportion are the ſame, and Radius being the firſt it follows; To the tangent of the arches greateſt latitude, add the fine complement of each vertical angle, and from their ſum abate Radius, the remainder is the tangent of their arches latitude required.

Arches greateſt Lat.	52,30 Ta.	10,115019	*a*	Latitudes of each Place.
	71 ,07 s.	9,975974		
	Remains	10,090993	tangent 50 ,58	*b*
	76 ,07 s.	9,987124		
	Remains	10,102147	tangent 51 ,41	*c*
The complement of the vertical angle	81 ,07 s.	9,994759		
	Remains	10,109776	tangent 52 ,10	*f*
	86 ,07 s.	1,999002		
	Remains	10,114028	tangent 52 ,26	*g*
	88 ,53 s.	9,999917		
	Remains	10,115035	tangent 52 ,30	*b*
	83 ,53 s.	9,997520		
Get the meridianal × of lat. by the table of meridianal parts, for they muſt all be done by Mercator.	Remains	10,112561	tangent 52 ,21	*f*
	78 ,53 s.	9,991774		
	Remains	10,104335	tangent 51 ,49	*k*

Remains

Remains	10,104335	tangent 51 ,45	*k*
73 ,53 S,	9,992587		
Remains	10.096922	tangents 51 ,21	*l*
68 ,53 S,	9,969811		
Remains	10,066733	tangent 49 ,23	*m*

For the course the proportions is, Note the difference of longitude common to all the proportions is 300 miles.

As mer. × of lat. 91	1,959041	Note this operation may be also contracted by subtraction.
Is to T. Radius 45 ,00	10,	
So is × of long, 300	2,477121	
To the tangent course	10,518080	T. 73 ,07 N, westerly, from *a* to *d*
Log 69 miles	1,838849	Substract
Remains	10,638272	T, 77 ,03 from *d* to *e*
Log. 47 miles	1,672098	Substract
Remains	10,805023	T. 81 ,06 N, westerly, from *e* to *f*
Log, 26 miles	1,414973	Substract
Remains	11,062148	T, 85 ,03 from *f* to *g*
Log, 6 miles	0,778151	Substract
Remains	11,698970	T, 88 ,51 from *g* to *h*
Log, 14 miles	1,146128	Substract
Remains	11,330993	T, 87 .19 from *h* to *i*
Log. 37 miles	1,568202	Substract
Remains	10,908919	T, 82 ,58 from *i* to *l*
Log. 57 miles	1,755875	Substract
Remains	10,721246	T, 79 .15 from *l* to *m*
Log, 78 miles	1,892095	Substract
Remains	10,555023	T, 75 ,26 from *m* to *c*

For the Distance, the Proportion is as follows,

As S, { 12 ,58 : 43 m, : : 90 ,00 : 192 m, from *d* to *e*
8 ,45 29 m, 187 m, from *e* to *f*
4 ,58 16 m, 185 m, from *f* to *g*
1 ,14 04 m, 186 m. from *g* to *h*
2 ,45 09 m, 188 m. from *h* to *i*
6 ,52 22 m, 184 m, from *i* to *k*
10 ,46 36 m, 193 m. from *k* to *l*
14 ,34 49 m, 194 m, from *l* to *m*
12 ,50 34 m, 112 m, from *m* to *c*

Which place orderly in the following table, but in regard, moſt of the courſes in the table are ſo near the weſt you may ſail W, N. W, 927 miles, until you are in the latitude of 56 ,00 N. and then W, S, W, 927 further, and you will arrive at the port deſired.

By this means you will alter the latitude ſix deg. which is conſiderable in reſpect of the benefit of obſervation, beſides the diſtance this way, is but 56 miles more than that of a great circle, and not above 24 m. more than the parallel or eaſt and weſt diſtance, which is evident if you compare them.

The Table.

places	places lat.	merid. parts	mer. x la	differ. of latitude	diff. of lat	Courſe from place to place	diſt. of places
	d. m.	miles		deg. m.	miles	d. m.	miles
A	50 ,00	3475	91	5 or 300	58	N. W. 73 ,07	200
d	50 ,58	3566	69	5 or 300	43	N. W. 77 ,02	192
e	51 ,51	3635	47	5 or 300	29	N. W. 81 ,06	187
f	52 ,10	3682	26	5 or 300	16	N. W. 88 ,02	185
g	52 ,26	3708	06	5 o 300	04	N. W. 88 ,46	187
h	52 ,30	3704	14	5 or 300	09	S. W. 87 ,15	186
i	52 ,21	3700	37	5 or 300	22	S. W. 83 ,08	184
k	51 ,59	3633	57	5 or 300	36	S. W. 79 ,14	193
l	51 ,23	3606	78	5 or 300	49	S. W. 75 ,26	194
m	50 ,34	3528	53	5 or 300	34	S. W. 72 ,18	111
c	50 ,00	3475	The whole Diſtance is ———				1819

Caſe 3d, Two places differing both in latitude and longitude, being given to find their diſtance on the arch of a great circle, the angles of a poſition, and the courſe and diſtance of each of them, and all that is required in great circle ſailing.

Note, When two places differ both in latitude and longitude, they are neither in one parallel nor under one meridian; of which there are

are three kinds, viz. 1ſt. one place under the equator, and the other in north or ſouth latitude. 2d. Both in north or both in ſouth latitude; and 3d. One place in north and the other in ſouth latitude.

Theſe three kinds of places differ both in lat. and lon. how to find their diſtance in the arch of a great circle, which have been ſhewn fully and at large, in the Geographical problems, [ſee foregoing work] but to find the angles of poſition, and what elſe, in great circle ſailing, is the work of the following problems.

Caſe 3d. The firſt kind, one place under the equator, the other in north or ſouth latitude, as for example.

Problem 1ſt. Suppoſe the Lizard, and the entrance of the River of Amazon; I demand the angles of poſition, the great circles diſtance between them, the latitude of the arch of every ten degrees of longitude, with the courſe and diſtance of each of them; according to Mercator.

The latitudes and longitudes of theſe places ſuppoſed to be as follows.

Lizard	Latitudes	50 ,00 N.	longitudes	5 ,24 W.
Amazon's River		00 ,00		48 ,04 W.
Their difference of Longitude				43 ,40

This problem is exactly projected in the firſt variety in Geography before going, and here note, that in the rectangled ſpherical triangle Z Æ N.

1ſt. Z Repreſents the Lizard.
2d. N The entrance of Amazon's River.
3d. Z Æ The latitude of the Lizard.
4th. Æ N their difference of longitude.
5th. Z Æ N The right angle equal 90 ,00.
6th. Æ Z N The angle of poſition at the Lizard.
7th. Æ N Z The complement of the angle of poſition at Amazon's, in the equator.
8th. Z N The great circles diſtance between them.

For the angle Æ N Z, or Æ Z N, is found by the proportion delivered in the foregoing work, which is as followeth.

As Radius : Is to the ſine of the latitude : : So is the tangent complement of the difference of longitude : To the tangent complement of the angle of poſition at the place having latitude. That is,

As

As Radius	90,00	10,
Is to ♎ lat. ♎ N	50,00	9,884254
So is T.C. leg. ♎ 47,20		10,035412
To tangent	49,44	9,919666

Again,

As Radius	90,00
Is to leg. ♎ N	42,40
So is T. C. leg. ♎ Z	40,00
To T. C. ∠ at the Equ.	29,38

From	90,00	From 90,00
Substract	49,44	Sub. 29,38
Rem. ∠ ♎ Z N	40,16	Rem. 60,22

Whence the angle of position at the River of Amazon is equal 60,22 equal ♎ N Z.

2d. For the hypothenuse N Z, equal the great circles distance, that is found by the proportion in geography to be 61,48 or 3708m.

3d. To find the latitude by which the arch shall pass at every ten degrees difference of longitude from z, representing the Lizard, observe the following direction,

Draw the meridians from P, as P *f*, P *g*, &c. which in the steriographical projection, on the plain of the equinoctial here described, are streight lines, and is thus done.

The Steriographical Projection of the last Figure.

1st. From the chords lay ten degrees on the equator, from ♎ to *f*, from *f* to *g*, and so on to *i*, &c. then draw the streight lines P *f*, P *g*, P *h*, P *i*, &c. which are meridians, and they cut the arch Z N, in *a*, *b*, *c*, and *d*, the respective places whose latitudes are required, then measure *a f*, and *b g*, on the scale of half tangents, the contrary way, and it sheweth the latitude of the arch at these places.

By Spherical Trigonometry it is thus,

The several pricked lines A E, *b g*, &c. are so many perpendiculars to as many right angled triangles, which have one common angle; ♎ A Z the complement of the angle of position at the place which is under the equator; now in each of these right angled triangles there is given a leg and its adjacent angle, to find the other leg, which is the leg opposite to the given angle, that is the triangle *a f* N, there is given the leg *f* N, and angle *a* N *f*, to find the leg *a f*, and so in all the rest of the triangles, and the several legs *a* N *g*, N, &c. are found by a continual substraction of the difference of ten degrees from the difference of longitude, till the remains be less than ten degrees. The remainder I call now vertical angles, and are thus found.

From

From the leg Æ N	42 ,40
Subſtract arch Æ *f*	10 ,00
The remainders are *f* N,	32 ,40
g N,	22 ,40
b N.	12 ,40
i N.	2 ,40

Then by ſpherical trigonometry rectangular, to find the ſeveral latitudes of the arch, the proportion is thus,

As Radius	90 ,00	10,
Is to ver. arch *f* N	32 ,40	9,732193
So is T. ∠ at *f*	60 ,22	10,245063
To T. arch la. at *f*	43 ,30	9,977190

As Radius	90 ,00	10,00900
Is to s. ver. arch	12 ,40	9.34099
So is T. angle	60 ,22	10,24500
To T. lat. *c*	21 ,05	9,58599

As Radius	90 ,00
Is to S. vertical arch	21 ,40
So is T. angle	60 ,22
To T. latitude *b*	34 ,07

As Radius	90 ,00
Is to S. vertical arch	2 ,40
So is T. angle	60 ,00
To the tang. latitude	4 ,41

Latitude of *a*	43 ,30
Latitude of *b*	34 ,07
Latitude of *c*	21 ,05
Latitude of *d*	4 ,41

Secondly, the courſe and diſtance from each of the places, are found by caſe 3d. of Mercator ſailing, in like manner as in the third ſtep in the laſt problem.

For the Courſe.

As mer. ✕ of lat.	571	2,75663
Is to tan. Radius	45 ,00	10,00000
So is ✕ of long.	600	2,77815
To tang. courſe	46 ,25	10,02152

As mer. ✕ of lat.	725	2,86034
Is to tan. Radius	45 .00	10.00000
So is ✕ of long.	600	2.77815
To tang. courſe	39 .37	9.91781

As mer. ✕ of lat.	884	
Is to tangent Radius	45 .00	
So is diff. of long.	600	
To the tang. courſe	34 .07	

As Mer. ✕ of lat.	1014	
Is to tang, Radius	45 ,00	
So is ✕ of long,	600	
To the tangent courſe	30 ,38	

As mer. ✕ of lat.	281	
Is to tang. Radius	45 ,00	
So is ✕ of long,	600	
To tangent courſe	29 ,38	

Courſe from *z* to *a* is S, 46 ,25 weſterly
Courſe from *a* to *b* is S, 39 ,37 weſterly
Courſe from *b* to *c* is S, 34 ,07 weſterly
Courſe from *c* to *d* is S, 30 ,38 weſterly
Courſe from *d* to *x* is S, 29 ,39 weſterly

Now we can find their ſeveral reſpective diſtances as followeth.

As

As S. C. course : Is to the difference of latitude : So is Radius : to the distance

43 ,25	390	90 ,00	571	distance from *x*	to *a*
50 ,23	560		731	*a*	*b*
55 ,50	782		945	*b*	*c*
56 ,31	984		1142	*c*	*d*
60 ,28	281		323	*d*	N

The Table shewing the whole Work.

Places	Places lat.	merid. parts	mer. × lat	differ. of long.	differ. of lat.	Courses from place to place		dist. of places
	d. m.	miles	miles	deg. m.	d. m.	points.	d. m.	miles
x	50 ,00	3475	571	10 or 600	6 ,30	S. W.	46 ,55	571
a	43 ,30	2904	725	10 or 600	9 ,23	S, W.	39 ,37	731
b	34 ,07	2179	884	10 or 600	13 ,02	S, W.	34 ,10	945
c	21 ,05	1295	1014	10 or 600	16 ,24	S. W,	30 ,28	1142
d	4 ,41	281	281	2,40 160	4 ,41	S, W,	29 ,39	323
N	00	00		The whole Distance is				3712

Case 3d. Both places in north or in south latitude, as suppose the Lizard and Barbadoes, it is required to find the angle of position, the great circles distance between them, the latitude of the arch at every ten degrees, difference of longitude, with the course and distance from each, according to Mercator.

The latitude and longitude of these places supposed as follows.

Lizard	Latitudes	50 ,00 N.	Longitudes	5 ,14 W,
Barbadoes		13 ,00 N.		57 ,54 W,
			Their difference of Longitude	52 ,30 W.

The stereographical projection of this problem being the same as in geographical problems before mentioned, where the construction may be seen at large; Then in the oblique angled spherical triangle LPZ, we have Z, which represents the Lizard in latitude 50 ,00, L Barbadoes, P Z the complement of the lat. of the Lizard equal 40, PL complement lat. of Barbadoes 77 ,00, PLZ their difference of longitude 52 ,00, LZP equal the angle of position at the Lizard, PLZ the angle of position at Barbadoes, and LZ the great circles distance between them.

For the angle LZP, and PLZ, the proportions, are

As the sine of half the complements of both latitudes : Is to the sine of half their difference : : So is the tangent complement of half their difference of longitude : To the tangent of half the difference of the angles of position

Again

As the fine complement of half the fum of the complement of both latitudes : Is to S. complement of half their difference : : fo is the tangent complement of half their difference of longitude : To the tangent of half the fum of the angles of position. The Operation.

Side Z P	40 ,00
Side L B	77 ,00
Sum of fides	117 ,00
Half fum of fides	58 .30
Difference of fides	37 ,00
Half difference of fides	18 .30

Difference of longitude	52 .30
	26 ,15
Their complements	63 ,45
	38 ,30
	71 .30

Then follows the proportions at large.

		co, ar.
As s. of half Z. fides	58,30	0,099234
Is to s. of half ×	18 ,30	9,501476
So is T, C. half × lon.	63,45	10,307025
To T, half × of ang.	37 ,02	9,877735
		co, ar,
As S. C. of half Z fides	31 ,30	9,281984
Is to S. C. half dif.	71 ,30	9,976957
So is T. C. ha. × lon.	63,45	10,307020
To T. half fum ang.	74,48	10,565897

As Radius	90 ,00	10,00000
Is to S. C, × long,	37 ,30	9.78445
So is T, C, lat.	40 ,00	9,92381
To T, fourth arch	27 ,04	9,70826
From S, C, leſſer latitude		77 ,00
Subſtract fourth arch		27 ,04
Remains reſidual arch		49 ,56

Half fum of angles	74 ,48
Half differ. of angles	37 .02
Angle P Z L	111 ,50
Angle Z L P	37 .46

For the fide L Z, the diſtance is as followeth.

As S. C. fourth arch	62 ,56
Is to S, C, reſid. arch	40 ,04
So is s. latitude	50 ,00
To the S.C. diſt, on the arch of gr. cirl.	33 ,37
Subſtract from	90 ,00
Remains	56 ,23

The diſt. 56 .23 which is 3383 m. or 1127 one 3d. lea.

To find the latitude by which the arch ſhall paſs at every ten deg. of difference of longitude from Z, repreſenting the Lizard, deſcribe the figure gnomonically, and then all the parts of it will be ſtreight lines, which is thus done.

The Problem Gnomonically Protracted.

1ſt. Make the angle L P Z equal 52 ,30, equal the difference of longitude.

2d, Make the side P Z, the tangent of 40 degrees, the complement of the Lizard latitude, and P L the tangent of 77 deg, the complement of Barbadoes latitude.

3d. Draw the line L Z, which is the great circles distance between them, and continue it beyond Z.

4th. From P, let fall the perpendicular P B, to cut L Z in B, which being measured on the scale of tangents is 36 ,38 the complement of the arches greatest latitude.

6ti. Then draw lines from P, each ten degrees distant from Z, as P *a*, P *b*, P *c*, &c. which are meridians, each 10 degrees of longitude from the Lizard and from each other, then measure P *a*, P *b*, P *c*, &c. on the scale of tangents, and it sheweth the complements of the latitude of the arch at the respective places *a*, *b*, *c*, &c.

These are found by calculation after this manner. First, in the right angled spherical triangle B P Z, their is given the hypothenuse P Z equal 40, angle B Z P equal 68 ,10, to find the side B P, and angle B P Z.

First to find the leg B P the complement of the arches greatest lat. say,

As Radius	90 .00	10,			
Is to S. C. gr. lat.	40 ,00	9,808068		From	90 ,00
So is S. ∠ position at the Lizard	68 ,10	9,967674		Substract	36 ,38
				Remains	53 ,22
To S. C. arch gr. lat.	36.38	9,775742		The aches greatest latitude.	

For the vertical angle P B Z, the proportoni is,

As Radius	90 ,00	10,	From	90 ,00
Is to S. gr. lat.	50 .00	9,884254	Substract	62 ,23
So is T, ∠ at Lizard	65 .10	10,397238		
			Remains	27 .27
To T. com. verti. ∠	62 ,23	10,281492	The vertical angle	

Secondly, to find the several latitudes of the arch at *a*, *b*, *c*, &c, you may consider that the several prick'd lines P *a*, P *b*, &c. are so many hypothenuses to as many several right angled triangles, which have one common leg B P, the complement of the arches greatest latitude,

2d. In each of them their is given a leg and its adjacent angle, to find the hypothenuse that is in the triangle *a* B P, their is given the leg B P, and angle A P B, to find the hypothenuse *a* P, and so in all the rest.

3d, And the several vertical angles, as *a* P B, *b* P *c*, *c* P B, &c. are found by a continual addition of ten degrees to the angle B P Z 27 ,37, till the same exceed not 80 ,07 the difference of longitude given, added to the aforesaid 27 ,37, that is,

To

To the angle B P Z	27 ,37
Add the angle A P Z	10 ,00
The sum is the ∠ a P B	37 ,37
∠ b P B	47 ,37
∠ c P B	57 ,37
∠ d P B	67 ,37
∠ e P B	77 ,37

These vertical angles being thus found, their several latitudes of the arch at *a*, *b*, *c*, *d*, &c. are found by the same proportions before going, being as followeth.

As Radius : Is to the s. comp. of the vertical angle : : So is the the tangent of the arches greateſt latitude : To the tangent of the arches latitude required. That is,

As Radius 90 ,00				Latitude at
S, 52 ,23	: : T. 53 22	: 46 ,49		*a*
S, 42 ,23	T. 53 22	42 ,11		*b*
S, 32 ,23	T. 53 22	35 ,46		*c*
S, 22 ,23	T. 53 22	27 ,07		*d*
S, 12 ,23	T, 53 22	16 ,05		*e*

For the courſe, the proportions are, As the meridianal difference of latitude : Is to tangent Radius : : So is the difference of longitude : To the tangent courſe.

As					
288 : 45 ,00	: : 600 :	64 ,22 s,	weſterly,	from x	to *a*
391		56 ,55		*a*	*b*
495		50 ,29		*b*	*c*
610		44 ,32		*c*	*d*
713		40 ,05		*d*	*e*
191		38 ,08		*e*	L

For the diſtances the proportions are, As ſine complement courſe : Is to the proper difference of latitude : : ſo is Radius : To the diſtance. That is,

As					
25 ,38	: 191 : : 90 ,00	: 441 m,	from x		*a*
33 ,05	278	509 m,	*a*	to	*b*
39 ,31	385	605 m,	*b*		*c*
45 ,28	519	728 m,	*c*		*d*
49 ,55	662	865 m,	*d*		*e*
51 ,52	185	223 m,	*e*		L

The Table ſhewing the whole Work.

Places	Places lat.	merid. parts	mer. ✕ lat	Diffe. of long.	Diffe. of lat.	Courſes from place to place	Diſt. of places
	d. m.	miles	miles	deg. m.	d. m.	points.	d. m. miles
Z	50 ,00	3475	288	10 or 600	3 ,11	S. W.	64 ,22 441
a	46 ,49	3187	391	10 or 600	4 ,38	S, W.	56 .55 509
b	42 ,11	2796	495	10 or 600	6 ,25	S, W.	50 ,29 605
c	35 ,46	2301	610	10 or 600	8 ,39	S. W,	44 ,32 728
d	27 ,07	1691	713	10 or 1601	1 .02	S, W,	40 ,05 865
e	16 ,05	978	191	10 or 160	3 ,05	S, W,	38 ,08 235
L	13 ,00	787		The whole Diſtance is			3283

Caſe 3d. One place in north latitude and the other in ſouth latitude.

Problem 4th. Cape Cod in New England, and the cape of Good Hope on the coaſt of Africa; I demand the angles of poſition, the great circles diſtance, and the latitude of the arch at every ten degrees difference of latitude, the courſe and diſtance from them according to Mercator ſailing.

The latitudes and longitudes of thoſe places ſuppoſed to be as follows.

Cape Cod.	Latitudes	42 ,10 N.	Longitudes	67 ,45 W.
Cape Good Hope		34 ,25 S.		17 ,10 E.
	Their difference of longitde being			45 ,55

In the oblique angled ſpher. trian, DPZ, in the following projection.

1ſt. Z. Repreſents Cape Cod in latitude 42 ,10 N.
2d. D Repreſents cape of Good Hope in latitude 34 .25 N
3d. PZ The complement of the latitude of cape Cod 47 ,50 ſouth
4th. P D The diſtance of the cape of Good Hope from the North-pole, or its latitude, added 90 degrees, being 124 ,25
5th. PDZ Their difference of longitude
6th. DZP Rrepreſents the angle of poſition at cape Cod
7th, PDZ The angle of poſition at the cape of Good Hope
8th. D Z Repreſents the great circles diſtance between them

For the angles D Z P, and P D Z, the General proportions. are,

Side P D	124 ,25			Angle D D Z	84 .55
Side P Z	47 ,50				
				Half thereof is	42 ,27
Z ſides	172 ,15			Which ſubt. from	90 .00
		Half Z	86 ,07		
✕ ſides	70 ,35	Half ✕	38 ,17	Its complement is	47 ,33

As

		co. ar.
As s. half z sides	86 ,07	0,000998
Is to s. half × sides	38 ,17	9,792077
So is T.C. half DPZ	47 ,33	10,038785
To T. half × ∠s	34 ,10	9,831777
As s. C. half z sides	3 ,53	1,169256
Is to s. C. half sides	51 ,43	9,894845
So is T. C. half DPZ	47 ,33	10,038708
To T. half z ∠s	85 ,29	11,102803

Half sum of angles	85 ,29
Half differ. of angles	34 ,10
Angle D Z P	119 ,39
Angle P B Z	51 ,19

Their distance on the arch of a great circle, is found as follows, the operation,

90 ,00 — 84 ,55 equal 5 ,05

As Radius	90 ,00	10,
Is to s. c. × long.	5 ,05	8,947456
so is T.C.L.cape cod	47 ,50	10,043023
To T. fourth arch	5 ,34	8,693289
As s. c. fourth arch	84 ,25	0,002065
Is to s. c. Resi. arch	28 ,50	9,683289
So is lat. cape cod	42 ,10	9,826910
To s. c. Z D the dist.	18 ,59	9,512259

Side DP	124 ,25
subst. fourth arch	5 ,35
Residual arch	118 ,59
subtract	90 00
Comp. R. arc	28 59
To	90 00
Add	18 59
Distance	108,59
	60
as was required,	6539m.

3. To find the latitude by which the arch must pass at each 10 degrees difference of longitude from Z representing cape Cod, delineate the problem stereographically upon the plain of the equator, and then although all the meridians will become right circles or straight lines, thus,

The Stereographical Projection of the last Figure.

Make the ∠ DAPZ equal 84 55 equal the diff. of lon. and make the side PZ equal the half tang. of 47 50 equal lat. of cape cod and PD 124 25 the lat. of the cape of good hope, added to 90 00 by the laws of spheric geometry, when one latitude is north, and the other south, then through Z and D, draw an arch of a great circle, and continue it beyond Z from P let fall the perpendicular PB to cut ZB in B which being measured on the scale of half tangents equal 40 00 equal the complement of the arches greatest latitude then draw the lines from P each 10 degrees distant from Z, as P *a* P *c* P *d* P *e*, &c. on the scale of half tangents, and it sheweth the complements of the latitude of the arch at these places, *a c d e*, &c,

These

These are found by calculation in this manner which in all respects is like the work in the last problem, for the leg B P, the complement of the arches greatest latitude, say,

As Radius	90,00	10,
Is to s. c. hyp. P Z	47.50	9,869933
So is s. ∠ B Z P	60,21	9,939052
To the leg B D	40,06	9.808985

From	90,00	
Substract	40,06	
Remains	49,54	

The arches greatest latitude,

For the Vertical angle D P B.

As Radius	90,00	10,
Is to s, c hyp, Z P	42,10	9,826910
So is tan, ∠ B Z P	60,21	10,244709
To tan. comp. ∠ B P Z	49,42	10,071619

From	90,00	
Substract	49,42	
Remains	40,18	

The vertical angle required,

Secondly, for the several latitudes at *a*, *c*, *d*, &c, add ten degrees to the angles B P Z, in continuation, eight times, which produceth the several vertical angles, *a* P B, *c* P B, *d* P B &c, and then the proportions follows, that is,

To the angle B P Z		40,18
Add the angle *a* P Z		10,00
The sum is the angle	*a* P B	50,18
	c P B	60,18
	d P B	70,18
	e P B	80,18
	f P B	90,18
	g P B	100,18
	b P B	110,18
	i P B	120,18

These vertical angles being thus found, the several altitudes of the arch at *a*, *c*, *d*, *e*, *f*, *g*, *b*, *i*, are found by the proportions following, which are the same as in the examples before going.

As Radius : Is to sine complement of the vertical angle : : So is the tan. of the arches greatest lat. : to T, of arch of the lat. required,

As 90,00 : *a* P B	39,42	: : T, 49,54 : T,	37,11	Latitude, at *a*
	29,42		30,26	*c*
	19,42		21,49	*d*
	9,42		11,19	*e*
	0,18		00,31	*f*
	10,18		11,59	*g*
	20,18		22,23	*b*
	30,18		30,56	*i*

For the courses they are found by the following proportions,

As the meridian difference of latitude ; Is to tangent Radius : : so is difference of lonitude : to tangent course.

As

As { 389 m. : 45 ,co :: 600 m, : 57 ,03 S. Eaſterly, from x to a
485 : 51 ,03 : a c
578 : 46 ,04 : c d
660 : 42 ,16 : d e
702 : 40 ,26 : e f
704 : 40 ,31 : f g
655 : 42 ,30 : g b
574 : 46 ,16 : b i
346 : 46 ,50 : i D

For the Diſtances the proportions are

As S, c, courſe : Is to the ✕ of latitude : : So is Radius : to the diſt.

As { 32 ,57 : 299 :: 90 ,00 : 550 m. from x to a
35 ,57 403 : 641 : a c
43 ,56 519 : 718 : c d
47 ,44 630 : 851 : d e
49 ,34 700 : 920 : e f
49 ,29 698 : 918 : f g
47 ,38 624 : 847 : g b
43 ,44 513 : 742 : b i
40 ,10 209 : 324 : i k

The Table.

places	places lat.		merid. parts		ner. ✕ la:	liffer. of longitude	diff. of lat.	Courſe from place to place		diſt. of places
	d.	m.	miles			leg. m.	miles		d. m.	miles
x	42	,10	N 2795		385	10 or 600	299	S. E.	57 ,03	550
a	37	,11	2406		48	10 or 600	403	S. E.	51 ,03	641
c	30	,28	1921		57[illegible]	10 or 600	519	S. E.	46 ,04	748
d	21	,49	1343		66[illegible]	10 or 600	630	S. E.	42 ,16	851
e	11	,19	688		705	10 or 600	700	S. E.	40 ,26	920
f	00	,21	S. 21		703	10 or 600	698	S. E.	40 ,31	918
g	11	,59	724		65[illegible]	10 or 600	624	S. E.	42 ,30	847
b	22	,23	1379		574	10 or 600	513	S. E.	46 ,10	742
i	30	,36	1953		249	10 or 600	209	S. E.	49 ,50	329
D	34	,25	T 2202							
						The whole Diſtance is	———			6541

Note, the arch of a great circle may be deſcribed on a mercators chart, and thereby much of the calculative work may be ſpared, for having ſeveral latitudes of the arch at every 5 or 10 degrees difference of longitude; theſe places by the uſe of the mercator chart, (ſee the rules ſhowing the uſe of the ſaid chart) may be prick'd down in the chart,

chart, and then with a black lead pencil draw lines from place place to which will represent the great circle, and so the courses and distances from each place to the other may be found, and at any time may be wiped out, and the chart to serve at any other time, as before.

Here I shall present the reader with several curious and entertaining questions which has not appeared in any book of navigation extent.

Question 1st. There are two ports in the northern hemisphere, lying under the arch of a great circle, the angle of position at the northermost port is 41 ,03, their difference of longitude is 630 miles; A ship sails from the northermost port in the arch of a great circle in the S. W. quarter, and in a certain number of days, arrives in the southermost port, which happened on the 20th of June, 1772, and in the afternoon the same day, finds the sun's greatest azimuth from the north. to be at three o'clock; I demand the ship's distance sailed, and also the latitude of both ports.

Solution. On the 20th of June 1772, the sun's declination is 21 ,38 N. the hour from noon three hours equal 45 ,00. Then say, As Radius: Is to s. c. hour equal 45,00: : so is sun's declination 21 ,38: to the tangent latitude arrived in equal 16 ,43; in the annexed scheme P N equal 73 ,17 comp. latitude of the southermost port L P equal their distance. In the right angled sperical triangle N Z L, we have.

As s. c. N L	73 ,17	10,522399	As Radius	90,00	10,
Is to Radius	90 ,00	10,000000	Is to s. side L N	73 ,17	9,982220
So is s. ∠ L N Z	79 ,30	9,992666	So is s. ∠ L N Z	10 ,30	9,260633
To s. c N Z	73 ,33	9,470267	To s. side L Z	10 ,04	9,242853

Then in the right angled spheric triangle L P Z, we have L P Z equal 45 .57, the complement angle of position, and side L Z equal 10 .04 to find P Z.

As Radius	90,00	10,	Then side N Z	73 .33
Is to T. c. ∠ of po.	45,00	10,060072	Substract P Z	11 ,38
So is T. side L Z	10 .04	9.244264	Remains	61 .55
To the side P Z	11 ,38	9,344336	Com. lat. of northermost port	

As s. ∠ of po.	41 .03	9.817378
Is to Radius	90 .00	10
So is s. side L Z	10 ,04	9.242526
To the side L P	15 ,26	9,425145

Answer, the latitude of northermost port 28 ,05 N. the latitude of southermost port 16 .43 N. and the distance sailed 15 .26 or 926 miles. Q E I.

Question

Queſtion 2d. On the 31ſt. of May 1773, a ſhip in north latitude, and in longitude 11 ,48 W. and the ſun's meridian altitude to be 44,02. on the ſame day another ſhip in a greaterweſt longitude, diſtant from the firſt ſhip in the arch of a great circle 865 miles, found the ſun's meridian altitude to be 34 ,53; I deſire to find the firſt ſhip's latitude and alſo the latitude and longitude of the ſecon ſhip,

Solution. The ſun's declination on the ſaid day being 22 ,00. The firſt ſhip's meridian altitude 44 ,02, then 90 ,00 — 44 ,02 equal 45 ,58, and 45 ,58 + 22 ,00 equal 67 ,58 firſt ſhip's latitude, and 90 ,00 — 34 ,53 equal 55 07 and 55 .07 + 23 ,00 equal 77 ,07 the latitude of the ſecond ſhip then in the oblique angled ſpherical triangle A P Z, three ſides are given viz, A P complement latitude of the firſt ſhip equal 21 ,19 equal Z P 10 ,12 the complement latitude of the ſecond ſhip and A Z equal 865 miles, equal 14 ,25, to find the angle at the pole or difference of longitude,

Side A P 21 ,19	Half ſum 23 ,57			
Side Z P 12 ,10	ſide oppo. 14 ,25			
Side A Z 14 ,25				co. ar.
	Remains 8 ,32		A P 21 ,19	9,439469
Z ſides 47 ,54		Containing ſides	Z P 12 ,10	0,076220
		Half ſum of ſides	23 ,57 s.	9,608467
Half ſum 23 ,57		Remainder	5 ,32 s.	9,171389
	S. 62 ,28			19,295545
	2			
				9,617772
Doubled	124 ,56		90 ,00 — 55 ,04 equal	
Subſtract from	180 ,00		34 ,56 the ✕ of long.	
			11 ,48 the given long.	
Remains c ✕ of long.	55 ,04		45 ,44 2d. ſhip's long.	

Anſwer, The firſt ſhips latitude 77 ,50 N. her difference of longitude 34,50 and longitude in 45 ,44 W. as was required.

Queſtion 3d. Suppoſe a ſhip ſails S. weſterly from a part in latitude 50 ,35 N, and longitude equal 11 ,30 weſt until her diſtance and difference of longitude together makes 1000 mile, the ſquare of her diſtance is equal to the ſum of the diſtance and difference of longitude multiplied by the difference of longitude; I demand her courſe and diſtance, and what latitude ſhe is in?

Solution, Let x equal the diſtance, y the difference of longitude, and a equal 1000, Then by the queſtion $x + y$ equal a and x equal $a - y$, and x^2 equal $a^2 - 2ay + y^2$, alſo x^2 equal ay by the data; then ay equal $a^2 - 2ay + y^2$, this equation being duly tranſpoſed y^2

$3ay$ equal $-a^2$, and by compleating the ſquare we have $y^2 - 3ay + \frac{9a^2}{4}$ equal $\frac{9a^2}{4} - a^2$ conſequently y equal $\frac{3a}{2} - \sqrt{\frac{9a^2}{4} - a^2}$ equal 382 miles, the difference of longitude, and 1000 — 382 equal 618 m, the diſtance.

But if the young navigator be not acquainted with Algebra, I have for their ſakes, given a general rule in words at length viz. Multiply the ſquare of the ſum of the diſtance and difference of longitude, by nine, and divide the product by four, and from the quotient ſubſtract the ſaid ſquare of the ſum, and extract the ſquare root of the remainder, which root ſubſtract from three times the ſum divided by two, they remainder is the difference of longitude equal 382, now having the diſtance and difference of longitude with one latitude given, you may find the courſe and difference of latitude by ſpherics, thus, $\frac{384}{60}$ equal 6 .24 the ✕ of longitude, and $\frac{618}{60}$ eqoal 10,18 the diſt, and in the oblique angled ſpherie $\triangle$ DCA, is given ſide CA equal 39 ,25, the complement latitude departed from, ſide A D equal 10 ,38 the diſtance and angle A C D equal 6 ,29 the difference of longitude, to find the angle C D A, and ſide C D, thus

As s. of the ſide A D	10 ,18	co. ar,	0,747627
Is to s. difference of longitude	6 ,24		9,047154
So is s. c. latitude departed C A	39 ,25		9,802748
To the s. angle C D A	23 ,19		9,547524

Suppoſe A E perpendicular to C F, then by the firſt axiom of ſpherical trigonometry oblique.

As Radius	90 ,00	10,000000
Is to s. C lat. dep.	39,25	9,802748
So is s. of lon. E C A	6,22	9,044895
To the ſide A E	4 ,02	8,847638
As the diſt, D A	10 ,38	9,252373
Is to Radius	90 ,00	10,000000
So is ſide A E	4.02	8,847638
To s, angle A D E	23 .08	9.595265
Subſtract from	90 .00	
Remains ∠ D A E	66 .52	

As Radius	90 .00
Is to diſtance C D	10 .15
So is s. ∠ A D E	66 ,52
To ✕ of lat,	9 ,28
Latitude departed from	39 ,28
Difference of latitude	9 ,28
Complement latitude	48 ,53

Hence the latitude come to is angle A D F 41 ,08 N. and her courſe s, 23 ,13 weſterly, as required.

Queſtion

Queſtion 4th. Three ſhips A, B, and C, ſailed from the latitude 52,10 N. A ſailed into the S. W. quarter, C in the S. E. quarter, B ſails on ſome courſe between A and C, they arrive at three different ports in one parallel of latitude, being equally diſtant from each other; the ſum of A and C, courſes was 68,30, the diſtance between A and C the two outer moſt was 80 miles, and the midlemoſt ſhip diſtance was 60 miles; quere without Algebra, the courſes and diſtance of A and C, B's longitude and latitude come to?

Sulution. In a plain triangle, having the vertical angle, the baſe, and the line biſecting the Baſe equal B D; to find the perpendicular B E, or the common difference of latitude. thus, As the baſe: to the ſum of the ſemi baſe and biſecting line, ſo is their diſference a fourth proportional; Then as Radius, to tangent of the vertical angle, ſo is the fourth proportional found, to common difference of latitude B E equal 54,86. The operation.

Half baſe		40
To which add		60
Their ſum is		100
The difference		20
As T. Radius	45.00	10,000000
Is to T. ver. ∠	65,30	10,341296
So is 4th. prop.	25	1,397940
To C. × of lat,	54,86	1,739236

Then as 80 is to 100 ſo is 20 to 25, the fourth proportional.

To find D E the diſtance between B and the perpendicular 60 × 60 is 36.00

54,86 × 54,86 equal 3009,6196

Remains	590,3804
Whoſe ſquare root is	24,3

To	40,0
Add	24,3
A, dep.	64,3
C. dep.	15,7

As the difference of lat.	54,9	1,739572
Is to T. Radius	45,00	10,000000
So is A departure	64,3	1,808211
To the T. courſe	49,35	10,068639

As B × of lat.	54,9	1,739572
Is to T. Radius	90,00	10,00000
So is the depar,	15,7	1,195900
To the T. courſe	15,58	9,456328

As S. A courſe	49,29	9,880988
Is to the depar.	64,3	9,808211
So is Radius	90,00	10,
To the diſt.	49,35	10,068639

As B. diſt.	60	1,778154
Is to Radius	90,00	10.
So is the depar,	24,3	1,385606
To S. courſe	23,03	9,607455

As S, co, courſe	15,58	9,439456
Is to the deparr.	15,7	1,195900
So is Radius	90,00	10,
To the diſt.	56,94	1,755444

Anſwer, As Courſe S, 49 ,35 weſterly, diſtance 845 miles, B's courſe S. 15 ,88 eaſterly diſtance 56 ,94 miles, Q E I.

Queſtion 5th, Suppoſe 2 ſhip's ſail from 1 port, the firſt ſhip A, ſailed in the S. E. quarter, and the ſhip B, in the S. W. quarter; the ſum of their courſes is 70 deg, the ſum of their departures being 540 m. their common difference of latitude was 280 miles; Quere each ſhip's courſe diſtance and departure ſeverally.

Solution. In the triangle ABC, having the angle A equal 70, the baſe B C equal 540, and the perpendicular A D equal 280; then by this therom ariſing from trigonometry, As tangent of the ſum of their courſes, Is to tangent Radius, ſo is half the baſe, to a fourth proportional, Then As half the baſe, Is to the difference between the perpendicular and the fourth proportional, ſo is the ſine of the ſum of the courſes, to the co, ſine of the ✕ the of angles at the baſe, equal the ✕ of the complements, of the courſes. The operation.

Half the baſe 540 equal 270. Then,

As T. ſum of courſe	70 ,00	10,438934
Is to half the baſe	270	2,431364
So is tan. Radius	45 ,00	10,000000
To s 4th proper.	98 .3	1,992430 co. ar.
As half the baſe	270	7,968636
Is to the ✕ between perp, and 4th prop.	181,7	2,257355
So is s. ſum courſe	70 ,00	9,972986
To s. c. ✕ of courſes	39 ,13	9,800977
Subſtract from	90 ,00	
Rem. ✕ of courſes	50 ,47	

280 — 98 ,3 equal 181,7 the difference between the perpendicular and fourth proportional. Then ſay.

Sum courſes	70 ,00
Difference of courſes	50 ,47
	120 ,47
Weſtermoſt courſe	60 ,23
	19,13
Eaſtermoſt courſe	9 ,36

Then A's courſe s. 60 ,23 w, B's courſe s. 9 ,36 eaſterly,

To find A's diſtance and departure.

As s. co. courſe	29 ,37	9,693865
Is to the ✕ of lat.	280	2,447155
So is Radius	90 ,00	10,000000
To the departure	567	2,753258

As Radius	90 ,00
Is to the diſtance	367
So is s. courſe	60 ,23
The departure	493,6

To find B's diſtance

As s, c, courſe	80 ,24	9,993575
Is to ✕ of lat.	280	2,447156
So is Radius	90 ,00	10,000000
To the diſtance	284	2,453281

Departure

As Radius	90 ,00
Is to the diſtance	284
So is s. courſe	9 ,36
To the departure	47,4

Anſ

Anſwer, A's courſe is s, 60 ,23 weſterly, diſtance 567 miles, departure 493,6 miles, B's courſe s. 9 ,36 eaſterly, diſtance 284 miles, departure 47,4 miles, as was required.

Queſtion 6th. *Suppoſe* on the 4th, of June 1773 a ſhip ſailed in the South weſt quarter from a certain port in north latitude, and in longitude 12 ,40 W. making her diſtance in the arch of a great circle 2804 miles, and as the end of 29 days, 8 hours, obſerved the ſun's azimoth from the north at ſetting to be 64 ,24, and the angle of poſition at the place of obſervation to be 37 ,14; I demand the latitude of the port ſailed from, and the latitude and longitude of the laſt port.

Solution. Firſt, 29 days 8 hours from the fourth of June, agrees with the 3d. of July at 8 at night, the ſun's declination for the ſaid time being 22 ,57 N. Then from 90 .00 ſubſtract the ſun's azimuth 64 ,24 the remainder is 25 ,36 the ſun's amplitude. Then

As s: ſun's amplitude 25 .36	9,635570	
Is to Radius 90,00	10,	
So is ſun's decl. 22 .57	9.590984	Hence the latitude come to is 25 ,30 N.
To s. c. lat. come to 64 .30	9.955414	

Now having the complement latitude come to equal 64 .30 and the diſtance on the arch of a great circle equal 2804 miles equal 46 .44 and the angle of poſition equal 37 ,14 from whence we find the complement latitude departed from, and difference of longitude in the following manner.

Sides	Complement latitude	64 .30	contained angle	37 ,14
	Diſtauce ſailed	46 .44		
	Sum of ſides	111 ,14	Half thereof	18 ,37
	Half Sum	55 ,37	complement	71 ,23
	Difference of ſides	17 ,46	comp. half ſum ſides	34 ,23
	Half difference	8 ,53	comp. half × of ſides	81 .07

		co. ar,	Half ſum's angles	79 ,06
As s. c. h. Z ſides	34,23	0,248162	Half × of angles	29 ,03
Is to s.c.half × ſides	81 ,07	9,994759		
So is T.c, half ∠ po.	71 ,23	10,472549	Great angle	105 ,09
To the T, half Z ∠	79 ,06	10,715470	Leſſer angle	50 ,03

As

		co, ar,
As s, half Z sides	55 ,37	0,083400
Is to s. half X sides	8 ,43	9,188712
So is T. c, ha, ∠ posi,	71 ,23	10,472549
T, T, half X ∠	29 ,03	9,744661
		co, ar.
As s. X of long,	50 ,03	0,115428
Is to s, dist, sailed	46 ,44	9,862234
So is s, ∠ of Position	37 ,14	9,781800
To s, c. lat. depar.	35 ,05	9,781459

Hence the difference of longitude is 50 ,03 west.

From	90 ,00
Substract	35 ,05
Latitude come to	54 ,55
Difference of long.	50 ,03
Longitude departed	12 ,40
Longitude come to	62 ,43 w.

Q E I,

The Doctrine of the Sphere, applied in sundry Astronomical Problems, useful in Navigation.

Astronomical Difinitions,

THE circles drawn upon the spheres surface are either great or less circle. First, great circles and their poles described,

Great circles are those which divides the globe or sphere into two equal parts, and are principally these six, viz, The equinoxial, the ecliptic, the meridian, the horizon, the azimoth, and the circle of longitude,

3d The equinoxial or equator, is a great circle of 90 degrees distant from each pole of the world, cutting all meridians at right angles, and divide the world into two equal parts called the north and south hemispheres, and is here noted with N A Q, in the following projection.

4th. The poles of the world are two fixed points in the heavens, demetrically opposite to each other, the one in the north hemisphere, called the north or artic pole, noted with N, and the other in the south hemisphere, called the south or antartic pole, noted with and see the projection.

5th. The axis of the world, is a line supposed to be drawn from pole to pole, about which the diurnal motions, as supposed from east to west is performed, is noted with P A I.

6th,

6th. The ecliptic is a great circle croſſing the equinoxial in two oppoſite points, the beginning of Aries and Libra, making an angle (called the ohliquity of the ecliptic) there with of 23 ,30. it is repreſented by A K. This circle is divided into twelve equal parts called ſigns, each containing 30 ,00, whoſe names is as, followeth.

ARIES	CANCER	LIBRA	CAPRICORNUS
TAURUS	LEO	SCORPIO	AQUARIUS
GEMINI	VIRG	SAGITARIUS	PISCES
called northern ſigns.		called ſouthern ſigns.	

6th, The zodiac is a zone or girdle, having eight degrees of latitude on each ſide of the ecliptic, in which ſpace the planets make their revolutions, being divided and diſtinguiſhed by the twelve ſigns.

7th. The poles of the ecliptic, are two oppoſite points 23 ,30 diſtant from the poles of the world, as K and L.

8th. The meridians are great circles, paſing through both poles of the world, and croſſeth or cutteth the equinoxial at right angles, as PAL and PML.

9th. The Colures are two meridians, dividing the equinoxial and ecliptic each into four equal parts, one of theſe paſſeth by the equinoxial points Aries and Libra, and is called the equinoxial Colure, as PAL, the other the beginning of Cancer and capricon, called the Solſtial Colure; a P Cancer Æ, and L capricorn ♑ in the projection.

10th, The ſun's meridian, is that meridian which paſſeth by the ſun's center; a ſtars meridian, is that meridian which paſſeth by the center or middle of that ſtar.

11th. The horizon is a great circle of 90 degrees diſtant from the zenith and nadir, cutting all azimuths at right angles, and dividing the world into to equal parts, the upper and viſible hemiſphere, and the lower and inviſible hemiſphere, this circle is repreſented by S A B.

12th, The Zenith and nader are two points diametrically oppoſite, and are the poles of the horizon, the zenith is the vertical point, or the point right over our heads, and the nader is directly oppoſite thereto, as Z N.

13th. The Azimuths, or virtical circles, are great circles, concurring and interſecting each other in the zenith and nader, and croſſeth the horizon at right angles, as ZCN and ZAN.

14th. The prime vertical, is that azimuth circle which paſſeth through the eaſt and weſt points of the horizon as is repreſented by ZAN.

14th

13th. The meridian of a place to that meridian which passeth by the zenith and nadir of the said place as is represented by SZPBNLS.

16th. Circles of longitude are great circles, and intersecting each other in the poles of the ecliptic, as KYL and KXL.

The lesser Circles defined.

Lesser or small circles are those which divide the sphere into two unequal parts, and are drawn parallel to some great circle, and therefore are called parallel circles; and are of three kinds, viz. parallels of declination, parallels of latitude, and parallel of altitude.

1st. Parallels of declination, are small circles parallel to the equinoxial, imagined to pass through every degree and minute of the meridian, between the equinoxial and each pole of the world as Cancer *f g*, and capricorn *b i*.

2d. The tropics are two parallels of 23 ,29 distant from the equinoxial, limiting the sun's greatest declination.

3d. The north tropic passeth the beginning of Cancer, and is called the tropic of cancer.

4th. The south tropic or beginning of capricorn, is called the tropic of capricorn.

5th. The polar circles are two parallels of declination 66 ,30 distant from the equinoxial, and 23 ,30 from each pole of the world.

6th. That which is adjecent to the north pole, is called the artic circle, as KNO, and the other the antartic circle represented by L *p r*,

7th. Parallels of laritude are small circles parallel to the ecliptic imagined to pass through every degree and minute of the colures between the ecliptic and the poles thereof, and are represented by WXY.

8th, Almicanters or parallels of altitude, are small circles parallel to the horizon, imagined to pass through every degree and minute of the meridian, between the horizon and the zenith, as *s t*.

These definitions being well understood and considered duly, make way for the following problems.

Spherical Trigonometry, applied in a great variety of Problems in Astronomy useful in Navigation. Problem. I.

The day of the month given to find the sun's place in the ecliptic, keep-

Keeping in mind the day on which the ſun enters the ſeveral ſigns, which are theſe.

Aries, March 22d.	*Libra*, September 23d.
Taurus, April 20th.	*Scorpio*, October 23d.
Gemini, May 21ſt.	*Sagitarius*, November 23d.
Cancer, June 22d.	*Capricorn*, December 23d.
Leo, July 23d.	*Aquarius*, January 23d.
Virgo, Auguſt 23d.	*Piſes*, February 23

The General Rule.

If at the day given the ſun be in the ſign proper to the given month, ſubſtract the day the ſun entered that ſign from the day given, and multiply the remainder into 59 m. 8 ſec. 12 thirds. 43 fourths, 47 fifths, &c. equal the ſuns motion in the ecliptic in one day, but 59d. 8m. may ſuffice for common uſe, ſo you have the degree and minute of that month's ſign the ſun is in.

Example 1ſt. I deſire to know the ſun's place the 27th of Auguſt 1773.

27 — 23 equal 4, and 59 ,8 × 4 equal 3 deg. 56 m. 32 ſec. the ſun's place in *Virgo*, found by multiplying 59 m. 8 ſec. by 4.

Rule 2d. If the ſun be in a ſign different from the proper ſign of the month, then from the number of days contained in the proceeding month, ſubſtract the day of the ſun's entering into that month's ſign to the remainder add the day of the month given, that ſum multiplied into 59deg. 8 m. the product will ſhew the degree ſun is in.

Example 2d. September 26th, 1773, required the ſun's place in the ecliptic.

30 — 25 equal 5. In September the ſun enters *Libra*, then 5 + 23 equal 28 days. See the operation.

59 ,8 7 6 ,53 ,56 4 27 ,35 ,44	Multiply by the ratio, of 28 that is 7 and 4, and the product is 27d, 35m, 44 ſec. as was required.

Lemma, the ſun's place given, to find the neareſt equinoxial point.

A General rule. Divide the ecliptic into four quarters or quadrants, thus,

First Quarter, *Aries*, *Taurus*, *Gemini*.
Second Quarter, *Cancer*, *Leo*, *Virgo*.
Third Quarter, *Libra*, *Scorpio*, *Sagitarius*.
Fourth Quarter, *Capricorn*, *Aquarius*, *Piſces*.

While the ſun is in the firſt and laſt quadrants, *Aries* is the neareſt equinoxial point, and in the two middle quadrants, *Libra* is the neareſt equinoxial point.

Problem 2d. The ſun's greateſt meridian altitude taken at noon on the longeſt and ſhorteſt day of the year at London given, to find the ſun's greateſt declination and latitude of the place.

Example. Suppoſe that with a quadrant or other inſtrument you had obſerved on June 22d, the ſun's meridian altitude 61 ,58, and on December 22d. the ſun's meridian altitude to be 14,58, Required the ſun's greateſt declination.

From Altitude	61 ,58	Mer. alti. 61 ,58	Comp, 28 ,02
Subſtract Altitude	14 ,58	Mer. alti, 14 .58	Comp. 75 ,02
Remains diſtant tropics	47 ,30	Taken on June 22d, and December 22d, their complement to 90 ,00, being their zenith diſtance.	
Half is ſun's greateſt decli.	23 ,30		
The ſun's zenith diſt,	28 ,02	From ſun's ſum diſtance	75 ,02
Add ſun's declination	23 ,30	Subſtract ſun's declination	23 ,30
Sum is latitude north	51 ,32	Remains latitude north	51 ,32

Problem 3d. The ſun's place in the ecliptic and his greateſt declination given, to find his right aſcenſion and preſent declination.

Definitions. 1ſt. Aſcenſion is the riſing of the ſun or ſtars, or any part of the equinoxial above the horizon, and the declination the ſetting of it.

2d. Right Aſcenſion is an arch of the equinoxial contained between the beginning of Aries and any meridian, and accounted according to the order and ſucceſſion of the ſigns, (or it is that degree and minute of the equinoxial counted as before) which cometh to the meridian with the ſun or ſtar, or with any part of the ecliptic, A M, in the following figure.

3d. Declination is an arch of the meridian, contained between the ſun or ſtar's center, and the equinoxial M C.

4th,

4th. The ſun's greateſt declination is an arch of the ſoſtitial colure, counted between the ecliptic and equinoxial, and is always 23,29, as Æ Cancer, and Q Capricorn.

Example. The ſun in Taurus 22,56; I demand his right aſcenſion and preſent declination.

In the right angled ſpherical triangle A M C.

1ſt. A M C, is the right angle.
2d. A C, the ſun's right aſcenſion from the next equinoxial pt.
3d. A M, the ſun's right aſcenſion from the ſame point.
4th. MAC, The ſun's greateſt declination.
5th. MC, The ſun's preſent declination.

Note, the ſun being in *Aries, Taurus, Gemini, Capricorn, Aquarius, Piſces*, the neareſt equinoxial point, is *Aries*; and being in *Cancer, Leo, Virgo, Libra, Scorpio, Sagitarius*, the neareſt equinoxial point is *Libra*.

The Stereographical Projection.

Deſcribe the primitive circle with a chord of 60, and quarter it with two diameters or right circles, as SAB and ÆAQ, make thr angle ÆAQ, 23,30, which in the problem, is repreſented by rhe diſtance between the tropic and equinoxial, on the ecliptic A 69, make A C equal 52,30, from the ſcale of half tangents, then having three points, Æ C Q, deſcribe a circle, through which complete the rectangled ſphericle triangle.

To meaſure the things required. Take the extent of the leg A B, in your compaſſes, and meaſure it on the ſcale of half tangents, ſhews 51,46. 2d, Reduce M c to the premitive circle, by its pole x, that is, lay a ruler on x, and the angular point c, cuts the premitive circle in e, then cÆ meaſured on the ſcale of chords is 18,54 the ſun's preſent declination. QEI.

Trigonometrical Proportions.

To find the ſun's right Aſcenſion.

As Radius	90,00	10,
Is to S. c. ſun's greateſt declination	66,30	9,962358
So is T, ſun's diſt. equinoxial point	54,15	10,142730
To T. Sun's Right Aſcenſion	51,52	10,105088

Note, this finds the ſun's right aſcenſion only when he is in the firſt quarter of the ecliptic, that is in Aries, Taurus, Gemini, but when the ſun is in the ſecond quarter viz. Cancer, Leo, or Virgo, it muſt

be ſubſtracted from 180 ,00; but when the ſun is in the third quarter, viz Libra, Scorpio, and Sagitarius, it muſt be added to 180 ,00; and in the laſt quarter, viz Capricorn, Aquarius, Piſces, it muſt be ſubtracted from 360 ,00; and ſo you have the ſun's right aſcenſion from Aries, for any place in the ecliptic deſired.

To find the ſun's preſent declination.

As Radius	90 ,00	10.	
Is to s. ſun's Gr. declination	20 ,30	9.600799	*Anſwer.*
So is S. ſun's place	54 ,15	9,909328	Son's R. Aſc 51,52
			Sun's P. dec. 18 ,52
To S. ſun's P. Decl.	15 ,52	9.510027	

Example 2d. The ſun being in 3 02 of Leo; required to find the ſun's right aſcenſion, and preſent declination.

To find the ſun's right Aſcenſion.		To find the the ſun's preſent declination.	
As Radius	00,00	As Radius	00 ,00
Is to s. ſun's de. from its eq. p.	66 ,30	Is to s. ſun's greateſt decli.	2 ,30
So is Tan, ſun's long.	57 ,28	So is s ſun's long.	57 ,28
To tan. ſun's Rig. Aſc.	55 ,11	To s. ſun's pr. decl	19 ,39

180 ,00 — 55 .11 equal 124 ,49 the ſun's right aſcenſion from *Aries*, and the ſun's preſent declination, 19 ,39 QEI

Problem 5th. The ſun's right aſcenſion being given, to find the ſun's longitude, or place in the ecliptic, and preſent declination.

Example. Suppoſe the ſun's right aſcenſion be 128 19; I demand his place in the ecliptic, and preſent declination.

In the right angled ſpheric triangle A M c, here is one leg and its adjacent angle given, viz. the leg A M, equal 51 ,51 equal the ſun's right aſcenſion, ſubſtracted from 180 ,00 degrees, and the angle c A M equal 23 ,30, to find his place in the ecliptic, and preſent declination.

For the ſtereographical projection, (ſee the laſt problem) I here intended to preſent the young navigator with a greater number of problems, but not having room in this treatiſe for their ſtereographical projections I ſhall ſhew a variety of ſolutions trigonometrically and inſtrumentally.

To find the ſun's preſent declination.	
As Radius	90 ,00
Is to ſun's right aſcenſion	51 ,41
So is T. ſun's gr. decli.	23 ,39
To T, ſun's preſent decl.	18 ,52

Inſtrumentally.

Extend the compaſſes from S. 90 ,00 to *S*. 51 ,41 that extent laid from tan. 23 ,29, gives tan. 18,52 the ſun's preſent decli.

To

To find the sun's place in the ecliptic.

As Radius	90 ,00
Is to s. c. sun's gr. decl.	66 ,31
So is T. c sun's Right as.	38 ,19
To T. co. sun's place	35 ,46

Whence the sun's place from Libra, is 54 .14, substract one sign, viz. the sun's place in 5 ,46, Vergo.

Again, Extend the compasses from S. 90 .00 to S. 66 ,31, that extent applied from T. 38 ,19 will give T, 35 ,46 the complement of the sun's place.

From	90 ,00
Substract	35 ,46
Remains	54 ,14
Substract	30 .00
Remains	24 ,14
Substract from	30 ,00
Remians	5 ,46

Problem 5th. The sun's greatest declination and present declination given, to find his place in the ecliptic, and the right ascension.

Example. Suppose the sun's declination be 16 ,39 south, decreasing, required his place in the ecliptic, and his right ascension from the first star of Aries.

By Trigonometrical Calculation.

To find the sun's right ascension.

As T. Sun's greatest decli.	23 ,30
Is to T. Radus	45 ,00
So is s, sun present, dec.	16 .39
To S. sun's right ascension	43 ,27

To find the sun's place in the ecliptic.

As sun's gr. declination	23 .30
Is to Radius	90 ,00
So is s. sun's present decl.	16 ,39
To s. sun's place AC.	45 ,50

Instrumentally, by scale and compasses.

Extend from T. 45 ,00 to tan. 66 ,30, that extent laid from tan. 16 .39, gives a fourth tangent against which you find on the lines 43 ,27 the sun's right ascension.

For the sun's place.

Extend from s. 23 ,30 to s. 90 ,00 that extent applied from s. 16 ,30 will you s, 45 56 the sun's place in ecliptic as required.

But this being his longitude from the nearest equinoxial point, the sun's declination s. declination is s. decreasing then 45 ,56 — 30 ,30 Again 50 ,00 — 15 ,57 equal 14 ,04, where the sun's place is in Aquarius 14 ,04 after the same manner,

From	360 ,00
Substract	43 ,27
Remains	316 ,33

Answer.

Sun's place	14 .04
Sun's right ascension	316 ,33

from Aries, as was required.

Problem

Problem 6th, The latitude of a place and the ſun's declination given to find his amplitude and aſcenſional difference,

Diſinition 1ſt, Latitude of a place, or latitude upon the earth is an arch of the meridian of that place contained between the zenith and equinoxial, as Z Æ, equal thereunto, is the height of the pole above the horizon B P, in the following figure.

2d, Amplitude, is an arch of the horizons contained between the ecliptic and equinoxial, and ſheweth how far the ſun or ſtar, riſeth or ſetteth from the eaſt or weſt points, as A R,

3d, Aſcenſional difference, is the difference between the right aſcenſion, or oblique aſcenſion, or deſcenſion, or it is an arch of the equinoxial, contained between the axis of the world, and that meridian which paſſeth by the ſun or ſtars center, or it is the point of the ecliptic, in their aſcenſion or decenſion.

4th. Oblique aſcenſion, is an arch of the equinoxial, contained between the beginning of Taurus and that part the equinoxial that riſeth with the center of the ſun or ſtar, or with any part of the ecliptic, in an oblique ſphere,

5th, Oblique deſcenſion, is an arch of the equinoxial, contained between the beginning of Aries, and that point of the equinoxial, that ſetteth with the center of the ſun or ſtar, or with any part of the ecliptic in an oblique ſphere,

Example, In the latitude 54 ,20 N, the ſun's declination 18 ,55 N, the ſun's amplitude and aſcential difference, as required.

The Stereographical Projection,

The premitive circle being deſcribed and quarter as before directed, making S A B the horizon, and Z A N equal the prime vertical with A at the center,

On the premetive circle (now the meridian of the place) lay the latitude 54 ,20 from B to P, and from Z to Æ, and draw the two diameters or right circles P A L, the axis of the world, and Æ A Q, the equinoxial. 3d, Lay the ſun's declination 18 ,55 from Æ to *d*, and from Q to *c*, and draw the parallel circle alſo with the tangent of its complements which cuts the horizon S A B in R. deſcribe the obliquecircle P R T. and it is done,

Then in the rectangle ſpherical triange P B R, in the annexed figure you will have as follows,

1ſt,

1ſt. P B R the right angle.
2d, P B the latitude or height of the pole, above the horizon.
3d. P R the complement of ſun's declination.
4th. B R the complement of his amplitude.
5th, B P R the complement of his aſcenſional difference.

To meaſure the things required, Take B R in your compaſſes and meaſure it on the ſcale of half tangents from 90,00, backwards, accounting 80 to be 10, 70 to be 20, &c. you will find 56,16, the complement of ſun's amplitude, which ſubſtract from 90,00 remains 33.44 the ſun's amplitude required.

Since the poles of both containing ſides are in one diameter, find the pole of the oblique circle P R I, which is *x*, then A *x* meaſured on the ſcale of half tangents ſhews the angle B P R equal 25.51, the ſun's aſcenſional difference required.

Trigonometrical Calculation.

To find the ſun's true amplitude.			Inſtrumentally,
As s, c, latitude	35,40	9,765720	Extend from s, 35,40
Is to Radius	90,00	10,000000	to s, 90,00, that extent
So is s, ſun's decl,	18,55	9,510802	applied from s, 18,55
To s, ſun's true amp,	33,44	9,745083	will give s, 33,44, the ſun's true amplitude,
To find the aſcenſional difference,			**By Scale and Compaſſes,**
As T, Radius	45,00	10,	Extend from T. 45,00
Is to Tan, latitude	54,20	10,144062	to T, 54,20 that extent
So is tan, declination	18,55	9,534916	applied from T, 18,55
To s, aſcen, difference	28,31	9,678978	will give a 4th tan, againſt which on the ſines we have 28,31,

Problem 7th, The latitude of a place, and the ſun's declination given to find the oblique aſcenſion or deſcenſion,

The general Rule,

1ſt. Find the right aſcenſion by the third Problem, where you have the greateſt and preſent declination given to find the ſun's place and right aſcenſion, and aſcenſional difference by the laſt problem,

2d, When the latitude and declination are both north or both ſouth, the aſcenſional difference found, as aforeſaid, added to and ſubſtracted from the ſun's right aſenſion. the firſt is the oblique deſcenſion. the laſt the oblique aſcenſion,

When the latitude and declination are one north and the other ſouth, then by adding and ſubſtracting as before, the firſt is the oblique aſcenſion, the later the oblique deſcenſion. Note, when you cannot ſubſtract, add 360 degrees to the right aſcenſion, and then ſubſtract; alſo when you have added, if the ſum exceed 360,00 ſubſtract 360 degrees there from, and the remainder is what was required.

Example 1ſt. In the latitude 51,32 N. the ſun's declination being 15,40 S. decreaſing; I demand the ſun's right aſcenſion, his aſcenſional difference, and conſequently, his oblique aſcenſion and deſcenſion.

Trigonometrical Calculation.

To find the ſun's right aſcenſion.		
As T. Radius	45,00	10.
So is T. co. great decli.	66,30	10,361698
So is T. ſun's pr, decli.	15,40	9,447870
To s, right aſcenſion	40,10	9,809560

For the aſcenſional difference.		
As T. Radius	45,00	10,
Is to T. latitude	51,32	10,099913
So is T. declination	15,40	9,447860
To Sun's aſcen. differ.	20,40	9.59737

From	360.00
Subract	40,10
Remains	319,50
Right aſcenſi.	319,50
Aſcenſional diff.	20,40
Oblique aſcen.	340.30
Oblique deſ.	99,10

Found by addition and ſubſtraction.

Problem 8th. The latitude of the place and the ſun's declination given, to find the ſun's riſing and ſetting, and alſo the length of the day and night.

The general Rule.

1ſt. Find the the aſcenſional difference by the laſt problem, which reduced into time by allowing as in the table following.

15d.	00	m, for one hour	} of time
1	00	for four min.	
00	15	for one min.	

2d, The aſcenſional difference being reduced into hours and minutes, add it to, and ſubſtract it from 6 hours, the one is ſun riſing, and the other ſun ſetting.

Note, When the latitude and declination are both north or both ſouth, the ſun riſeth before ſix, and ſets after ſix, but if one be north north and the other ſouth, he then riſes after ſix, and ſet before ſix o'clock.

2d,

2d. If you double both the time of ſetting and riſing; the firſt is the length of the day, the latter the length of the night.

Example 1ſt. In the latitude 54 ,20 N. the ſun having north declination 22 ,37; Required the ſun's amplitude, aſcenſional difference, together with the ſun's riſing and ſetting, and length of the day and night.

Trigonometrical Proportions.

To find the ſun's amplitude and aſſenſional difference.

As s c. latitude	35 ,40	As tangent Radius	45 ,00
Is to Radius	90 ,00	Is to tangent latitude	54 ,20
So is s. ſun's declina.	22 ,37	So is T. ſun's declination	22 ,37
To s. ſun's amplitude	41 ,18	To s. ſun's aſcen. diſt.	35 ,29

The aſſenſional difference turned time as follows.

30 deg. is two hours
5 deg. is 20 minutes } of time
29 min. is two minutes

That is two hours, twenty-two minutes, the aſſenſional difference in time as required.

To find the length of the day and night.

To	6 h. 00 m.	Then 8 h. 22 m. × 2 equal 16 h. 24 m. length of the day,
Add	2 22	
Sun Riſing	8 22	And 3h. 38 m. × 2 equal 7h. 16m. length of the night, as required.
Sun ſetting	3 38	

Problem 9th. The latitude of a place, and ſun's aſcenſional difference being given, to find his declination and amplitude.

Example 1ſt. In the latitude 54 40 N. the ſun riſeth at 38 minutes paſt 3; required the ſun's declination and amplitude.

From	6h. 00 min.		
Subſtract	3 38		
Remains	2 22	Aſ. Diff.	
× by ratio	5	of 15	
	11 50		
	3		
	35 30	Sun's Aſc.	

5 and 3 differ, in degrees.

Trigonometrical Proportions.

As Radius	90 ,00	10,000000
Is to s. ſun's aſc. diff.	35 ,30	9,763954
So is T. C. latitude	35 ,40	9,855938
To T. ſun's declina.	22 ,37	9,679892

To find the Sun's Amplitude.

As s. Latitude	54 ,20	9,009782
Is to Radius	90 ,00	10,000000
So is tangent aſcenſional difference	35 ,30	9,853268
To tangent amplitude	41 ,17	9,943486

Arithmetically by Natural Sines and Tangents.

N. S. 35 ,40 — is equal .5807
N. S, 35 ,40 is equal ,7177.

Radius 1. Then 1 : .5807 : : .7177, viz. ,5807 × .7177 equal ,4167 &c. the natural tangent of 22 ,37 the ſun's declination required.

For the ſun's amplitude.
N. S, 54 ,20 equal ,8124
N. T. 54 ,30 equal ,1,402

Then 1 : ,8124 : : 1,402 : 1,1389 hence the N. T. 1,1389 equal 48 ,43 the comp amplitude, and the amplitude 41 ,17.

Arithmetically by Scale and Compaſſes.

For the ſun's declination.

Extend from s, 90 ,00 s, 35 ,30 the aſcenſional difference, that extent laid from the tangent 35 ,40 (the comp. latitude) will give tangent 22 ,37, the ſun's declination,

To find the ſun's amplitude.

Extend from s, latitude 54 ,90, to s, 90 ,00, that extent laid from Tangent 35 ,30, the aſcenſional difference, will give Tangent 41 ,17, the ſun's amplitude required,

By MARTIN'S *Sliding Rule,*

To find the ſun's declination.

Set s. 90 ,00 on the ſlider to s. 35 ,30 (the aſc. diff.) on the rule, then againſt tangent 35 ,40 (com. lat,) on the ſlider, you will have tangent 22 ,37 on the Rule, the ſun's declination.

To find the ſun's amplitude by the ſliding rule.

Set s. 54 ,20 on the ſlider, to s. 90 ,00 on the rule, then againſt T. 35 ,30 (the aſcen, diff.) on the ſlider, you will have tangent 41 ,17 on the rule, the ſun's amplitude required.

Problem 10th, The latitude of a place, and the ſun's amplitude being given, to find his declination and aſcenſional difference.

Example. In the latitude 54 ,20 N. the ſun's amplitude being 41 ,17 N. Required the ſun's declination and aſcenſional difference?

To

Trigonometrical Proportions.

To find the ſun's declination		For the ſun's aſcen. difference.		
		As T, c. ampli.	48 ,43	10,0565
As Radius	90 ,00	Is to s, latitude	54 ,20	9,9099
Is to s, c. latitude	35 ,40	So is Radius	90 ,00	10,0000
So is s. ſun's amp.	41 ,17			
To the s. ſun's decl.	22 ,37	To T. aſc. differ.	35 ,40	9,8532

Or thus			Or thus,	
As s. latitude	54 ,20	9,90918	As Radius	90 ,00
Is to Radius	90 ,00	10,00000	Is to s. latitude	54 ,20
So is T. C, amp,	40 ,43	10,05650	So is T. amplitude	41 ,17
			To T. aſcen, diff.	35 ,47
To T, C, aſcen, diff,	54 ,30	10,14672		

Inſtrumentally by Scale and Compaſſes.

To find the ſun's declination,

Extend from s, 90 ,00 to s, 35 40, the complement latitude, that extent applied the ſame way from s, 41 17 (the ſun's amplitude) will give s, 22 ,37 the ſun's declination required,

To find the ſun's aſcenſional difference,

Extend from s, 90 ,00 to s, 54 20 the latitude, that extent laid the ſame way from T. 41 ,17 the ſun's amplitude, will give Tan, 35 ,30 the ſun's aſcenſional difference required,

By MARTIN'S *Sliding Rule,*

Set s. 90 ,00 on the ſlider to s, 35 ,40 on the rule, then againſt s, 41 ,17 on the ſlide you will have s, 22 ,37 on the rule, the ſun's declination required,

Again to find the ſun's aſcenſional difference.

Set s, 90 ,00 on the ſlider to s, 54 ,20 on the rule, then againſt tangent 41 ,17 the amplitude on the ſlider, you will have tang. 35 ,30 on the rule, the ſun's aſcenſional difference required,

Problem 11th, The ſu's declination and amplitude being given, to find the latitude of the place, and the aſcenſional difference,

Example, Suppoſe the ſun's declination be 22 ,37 N, and his amplitude 41 ,17 N, I deſire to know the latitude of the place, and the aſcenſional difference?

Tri-

Trigonometrical Proportions.

To find the latitude of the place.			Inſtrumentally
As T ſun's amp,	41 ,17	9,119401	
Is to s, ſun's decli,	22,37	9,584969	Extend from s, 41 ,17 to s, 22 ,37, that extent laid from s, 90 ,00 gives s, 38 ,40 the complement latitude
So is Radius	90 ,00	10,000000	
To s, c, latitude	35 ,39	9,765568	
To find the aſcenſional difference,			Again extend from s, 67,23 (the c. ſun's declination) to s, 90 ,00 that extent applied from s, 48 ,43 gives s. 54 ,30 the comp, aſcenſional difference required
As s, c, declination	67 ,23	9,965248	
Is to Radius	90 ,00	10,000000	
So is s, c, amp,	48 ,43	6,875904	
To s, c, aſcen, diff,	54 ,30	9,910656	

Anſwer { Latitude required 54 ,20 N, / Aſcenſional difference 35 ,30 } as required,

Problem 12th, the ſun's declination, and aſcenſional difference given, to find the latitude of the place and the ſun's amplitude.

Example, Suppoſe the ſun's declination be 22 ,38 and the ſun riſeth 2 hours 22 minutes before ſix; required the latitude of the place and the ſun's amplitude?

2 22
3
7 6
5
35 30

Sun's aſcenſional difference in degrees of the ecliptic is 35 ,30, then the complement of the aſcenſional difference is equal 54 ,30.

Trigonometrical Proportions:

To find the latitude of the place			Inſtrumentally by ſcale and Compaſſes,
As Radius	90 ,00	10,000000	Extend from s, 90 ,00 to s, 35 ,38 the aſcenſional difference, that extent laid from tang. 67,23 the ſun's declination, will give T. 54 ,20 the latitude required.
Is to s. aſc. diff.	35 ,30	9,763954	
So is T. c. dec,	67 ,23	10,380279	
To T. lat.	54,20	10,144233	
To find the ſun's amplitude,			To find the ſun's amplitude.
As Radius,	90 ,00	10,000000	
Is to s. c. ſun de.	67,23	0,965248	Extend from s, 90 ,00 to s. 67,23 the comp. declination, that extent laid from s. 54 ,30 (co. aſcen, difference will give s. 48 ,43 (the com. amp.) hence ſun's amp, is 41 ,17 E, N, as was required.
So is s, c. aſ. dif.	54,30	9,910686	
To s. c, amp.	48 ,43	9,875934	
Subſtract from	90 ,00		
Remains	41 ,17	ſun's amp.	

By

By Mr. MARTIN's *Sliding Rule.*

First, for the latitude. Set s. 90 ,00 on the ſlider, to s. 35 ,30 on the rule; then againſt tangent 67 ,23 on ſlider, you will have tangent 54 ,20 on the rule, the latitude required.

For the ſun's amplitude. Set s. 90 ,00 on the ſlider to s. 67 ,23 on the rule, then againſt s. 54 ,30 on the ſlider you will have s. 48 ,43 on the rule, the complement of the ſun's amplitude; hence the ſun's amplitude is equal 41 ,17 E. northerly, as was required.

Problem 13th. The ſun's amplitude and aſcenſional difference being given, to find the latitude of the place and the ſun's declination.

Example. Suppoſe the ſun's amplitiude be 41 ,17 E. northerly, and the aſcenſional difference equal 35 ,30 as before in the laſt problem; Required the latitude of the place and ſun's declination.

Trigonometrical Proportions,

To find the latitude of the place,			To find the ſun's declination		
As T. c. aſc. diff.	44 ,30	10,146732	As s. c. aſcen. diff.	54 ,30	
Is to T. c. amp.	48 .43	10,056502	Is to s. c. amplitude	48 ,43	
So is Radius	90 ,00	10,000000	So is Radius	90 ,00	
To the s. latitude	54 ,10	9,909770	To s. ſun's dec.	67 ,23	
			Then 90,00—67,23 equal 22 .37 the ſun's declination.		

Inſtrumentally by ſcale and compaſſes,

Extend from tangent T. 54 ,33 to tangent 48 ,43, that extent laid the ſame way from s. 90 .00 will give s. 54 ,20 the latitude required.

Again, Extend from s. 54 ,30 the aſcenſional difference, to s, 48.43 the com. amplitude, that extent laid from s. 90 .90 the ſame way will give s. 67 .23 the com. declination, hence the ſun's declination is 22 .37 N. QE I.

By MARTIN's *Sliding Rule,*

Set tangent 54 ,30 on the ſlider to tangent 48 ,43 on the rule; then againſt s. 90 .00 on the ſlider you will have s. 54 ,20 on the rule, the latitude of the place required.

To find the declination. Set s. 54 ,30 on the ſlider to s, 48 ,43 on the rule; then againſt s, 90 ,00 on the ſlider you will have s, 67,23

on

on the rule, the comp. declination; hence 90 ,00 — 67 ,23 equal 22 .37, the ſun's declination required,

Arithmetically by Natural Sines and Tangents.

N. Tang. 54 ,30 is equal 1.402
N. Tang. 48 ,43 is equal 1,139

Radius equal 1. Then will

$$1.402 : 1{,}139 :: 1 : \frac{1{,}139 \times 1}{1{,}402}$$

equal ,8124 the N. S. of 54 .20 the latitude required.

To find the ſun's declination,
N. S. 54 ,30 equal ,8141 N. S. 48 ,43 equal .7515 Rad, 1. Then

$$,8141 : 7515 :: 1 : \frac{.7515 \times 1}{,8141}$$

equal ,9231, the N. S, of 67 ,23, the co. declination, then will 90 .00 — 67.23 equal 22 ,37 the ſun's declination.

Problem 14th. The latitude of a place and the ſun's declination being given, to find the ſun's altitude and azimuth at the hour of ſix.

Diffinition 1ſt, Altitude is an arch of azimouth circle, contained between the horizon and a parallel of altitude, as b f. in the figure.

2d. Azimuth is an arch of the horizon, contained between the meridian of the place and any azimuth circle, or contained between the prime vertical, and any other azimuth circle, as a b, in the projection.

Example 1ſt, In the latitude 51 ,32 N. and ſun's declination 23 .29 north; Required his altitude and azimuth at the hour of ſix in the morning; Note, at ſix o'clock the ſun is upon the axis P A I.

In the Rectangled triangle *a b f.*

1ſt, A *b f* is the Right Angle,
2d, *b* A *f* The Latitude of the Place.
3d, A *f* The Sun's Declination.
4th. *b f* The Sun's Altitude.
5th. A *b* His Azimuth from the Eaſt at ſix in the Morning, and from the Weſt at ſix in the Evening northerly in north latitude, and ſoutherly in ſouth latitude,

The Stereographical Projection. Pl. IV, Fig, 182

Having drawn the premitive circle, and quartered it with two diameters, making S A B the horizon, and Z A N, the prime vertical.

2d. Lay the latitude 51 ,32 from B to P, and from Z to Æ, and draw the axis of the world P A L, and Æ A Q, the equinoxial, which forms the angle *f* A *b* equal 51 ,32.

3d.

3d. Lay the chord of 23 ,29 the declination, from Æ to *c*, and from Q to *d*, then with the tangent of 66 ,30 draw the parallel circle *e f d*.

5th. Then through the three points Z *f* and N, deſcribe the oblique circle which cuts the horizon in *b* and the point *f*, on the axis P A L, and it is done.

The requiſits are meaſured exactly by the foregoing problems for the azimuth A *b*, meaſured on the half tangents, ſhews 15 ,07. then find the poles of the two containing ſides, and reduce the pole of the oblique circle, to the primitive circle, which is *n*, then B*n*, meaſured on circle the ſcale of chords, ſhews 18 ,11 the ſun's altitude required,

Trigonometrical Proportions.

To find the ſun's Altitude.			Inſtrumentally,
As Radius	90 ,00	10,000000	
Is to s. ſun's dec,	23 ,29	9,600409	Extend from s, 90 ,00 to s, 23,29, that extent applied the ſame way from s. 51 .32, will give s, 18 ,11 the ſun's al.
So is s. latitude	51 ,32	9,893745	
To s. ſun's alti.	18 ,11	9,494154	
To find the ſun's azimuth.			Again, extend from s, 90 ,00 to s, 38 ,28, that extent laid the ſame way from tangent 23 ,29, will give tangent 15 ,07 the ſun's azimuth from eaſt or weſt,
As Radius	90 ,00	10,000000	
Is to s. c. lat.	38 ,28	9,793832	
So is T. ſun's dec.	23 ,29	9,637956	
To tan. azimuth	15 ,07	9,431188	

Problem 14th, The latitude of the place and ſun's altitude at the hour of ſix being given, to find his declination and azimuth,

Example, In the latitude 54 ,10 N, the ſun's altitude at the hour of ſix is 15 ,02; Required the ſun's declination and azimuth at the ſame time,

The ſtereographical projection is omitted, by reaſon the laſt figure repreſents the data and Queſita of this queſtion.

Trigonometrical Proportions,

To find the ſun's declination,			Inſtrumentally by ſcale and Compaſſes,
As s, latitude	54 ,10	9,908173	Extend from s, 54 ,10 to s, 90 ,00, that extent laid the ſame way from s. 15 ,02 will give s, 18 ,40 ſun's declin^{a}.
Is s, ſun's altitude	15 ,02	9,413938	
So is Radius	90 ,00	10,	
To s. ſun's dec.	18, 40	9,505065	

To

To find the ſun's azimuth.

As Radius	45 ,00	10,
Is to T c. lat,	35 .50	9,858602
So is T. ſun's al,	15 ,02	9,429062
To s, ſun az, at ſix	11,17	9,297664

For the ſun's azimuth,

Extend from tangent 45 ,00 to tan. 35 .50, that extent laid the ſame way from tan. 15 02, will give a 4th tan, againſt which on the ſlide will give 11 .11 the ſun's azimuth required.

By MARTIN's *ſliding Rule.*

Set s, 54 ,10 on the ſlide to s, 90 ,00 on the rule, then againſt s, 15 ,02 on the ſlider, you will have 18 ,40 on the rule, the ſun's declination required.

To find the ſun's azimuth.

Set tangent 45 ,00 on the ſlider, to tangent 35 ,50 on the rule; then againſt tangent 15 ,02 on the ſlider, you will have a 4th tangent on the rule; againſt which on the line of ſines, you will have 11 ,11 the ſun's azimuth from the eaſt, as was required.

Problem 15th. the latitude of the place and the ſun's azimuth at the hour of ſix being given, to find the ſun's declination and altitude.

Example, In the latitude 54 .10 N, the ſun's azimuth being 13 .42, it is required to find his declination and altitude at the hour of ſix.

See the projection in the 13th problem, wherein we have one leg and its adjacent angle given, that is the leg A b equal 13 ,42, the ſun's azimuth, and the angle b A f, 54 ,10, the latitude of the place to find the declination and altitude.

Trigonometrical Proportions.

To find the ſun's declination.

As Radius	90 ,00	10,
Is to s, c. latitude	35 .50	9,767475
So is T. c, azimuth	76 .18	10,614013
To T, ſun's decl.	67 .23	10,380488
Or, As s. c, latitude	35 ,50	9,767475
Is to Radius	90 ,00	10,
So is tangent azimuth	13 .42	9,386987
To the tangent decl.	22 ,37	9,619512

Inſtrumentally by ſcale and compaſſes,

Extend from s, 35 ,50 to s, 90 .00, that extent laid the ſame way from tangent 13 ,42 will give tangent 22 .37, the ſun's declination required.

To

To find the ſun's altitude at the hour of ſix.

As Radius	90 ,00	10,
Is to s. az.	13 ,42	9,374452
So is T. lat.	54 ,10	10,141385
To T. al. at hour of ſix	18 ,09	9,515850

By ſcale and Compaſſes.

Extend from s. 90 ,00 to azimuth, equal 13 ,42, that extent applied the ſame way from tangent latitude 54 ,10, will give tangent 18 ,09 the ſun's altitude required.

Problem 17th. The ſun's declination and altitude being given, to find the latitude of the place, and the ſun's azimuth at ſix.

Example. Suppoſe the ſun's declination be 22 ,37 N. and the ſun's altitude at the hour of ſix equal 18 ,09 A M, Required the latitude of the place and the ſun's azimuth.

Trigonometrical Proportions,

To find the Latitude of the Place

As s. ſun's decli.	22.37	9,584969
Is to Radius	90 ,00	10,000000
So is s. ſun's altitude	18 ,09	9.493466
To the s. latitude	54 ,06	9,908497

Inſtrumentally by ſcale and Compaſſes.

Extend from s. 22 ,37 to s, 90, that extent laid the ſame way from s. 18,09 will give s. 54 ,06 the latitude required.

To find the ſun's azimuth.

As s. c. ſun's altitude	17 ,51	9,977835
Is to Radius	90 ,00	10,000000
So is s. c. ſun's deli.	67 ,23	9,965248
To s. c. ſun's az	76 ,16	9,687413
Subſtract from	90 ,00	
Rem. ſun's azimuth	13 ,44	Required.

By ſcale and compaſſes.

Extend from s. 71 ,51 to s. 90 ,00, that extent laid the ſame way from s. 67 ,23, will give s. 76 ,16 which taken from 90 ,00 rem. 13 ,44, the ſun's az. required,

By MARTIN's *Sliding Rule,*

To find the latitude, Set s. 22 ,37 on the ſlider to s. 90 ,00 on the rule; then againſt s. 18 ,09 on the ſlider you will have s. 54 ,06 on the rule, the latitude required. And to find the ſun's azimuth, ſet s, 71 ,51 on the ſlider to s. 90 ,00 on the rule, then againſt s, 67 ,23 on the ſlider you will have s. 76 .16 on the rule, which ſubtract from 90 ,00 remains 13 ,44, the ſun's azimuth,

Problem 18th, The ſun's declination and azimuth at the hour of ſix being given, tofind his latitude and altitude.

Example. Suppoſe the ſun's declination be 22 ,37 N, and the ſun's azimuth at the hour of ſix equal 13 ,44 E, ſoutherly; Required the latitude of the place and the ſun's altitude.

Trigonometrical Proportions.

To find the latitude of the place.

As tangent Radius	45 ,00	10,000000
Is to T, ſun's azimuth	13 ,44	9,388084
So is T. c, ſun's decli.	67 ,23	10,380279
To s, c latitude	35 ,55	9,768363
Subtract from	90 ,00	
The latitude	54 ,08 N. required.	

To find the ſun's altitude.

As s, c, ſun's az,	76 ,16	9,987403
Is to Radius	90 ,00	10,000000
So is s c, ſun's decli,	67 ,23	9,965258
To s. c. ſun's alti.	71 ,51	9.977815

Which ſubſtracted from 90,00 remains 18 ,09 the ſun's azimuth required,

Inſtrumentally by ſcale and compaſſes.

Extend from t. 45 ,00 to tangent 13 ,44, that extent laid from tan. 67 ,23 gives a 4th tangent, againſt which on the ſines is 35.55 the co. lat. hence the latitude is 54 .05.

To find the Altitude.

Extend from s, 76 ,16 to s. 90 ,00 that extent laid from s. 67 ,23 will give s. 71 51 the complement of the ſun's altitude, hence the ſun's alt. is 18,09 as was required.

By MARTIN's *ſliding Rule.*

To find the Latitude.

Set tangent 45 ,00 on the ſlider to tangent 13 ,44 on the rule, then againſt tangent 67 ,23 on the ſlider you will have a fourth tangent on the rule, againſt which on the ſines you will have s. 35 55, whoſe complement to 90 ,00 is 54 ,05 the latitude required.

Then to find the ſun's Altitude,

Set s. 76 ,16 on the ſlider to s. 90 ,00 on the rule, then againſt s. 67 ,23 on the ſlider you will have s. 71 ,51 on the rule, the complement of 18 ,09 the ſun's altitude required.

Problem 19th. The ſun's azimuth and altitude at the hour of ſix being given, to find the latitude of the place and the ſun's declination.

Example. Suppoſe the ſun's azimuth be 13 ,44 W. ſoutherly, and his altitude at the hour of ſix is 18 ,09; Required the latitude of the place and ſun's declination,

Tri-

Trigonometrical Proportions,

To find the latitude of the place.

As Radius	90,00	10,000000
Is to s. ſun's az.	13,44	9,375487
So is T. c. altitude	71,51	10,484369
To T, c, latitude	35,54	9,8956

Hence the latitude is 33,04,

To find the ſun's declination,

As Radius	90,00	10,000000
Is to s, c. azimuth	76,16	9,987403
So is s, c, altitude	71,51	9,977875
To s, c, declination	67,23	9,965278

Then 90,00 — 67,23 equal 22,37 the ſun's declination required,

Inſtrumentally by ſcale and Compaſſes, To find the latitude of the place,

Extend from s, 90,00 to 13,44 the ſun's azimuth; that extent laid from T, 71,51 the com. ſun's alt. will give tan, 35,54 the com, latitude hence the latitude is 54,06N,

For the ſun's declination,

Extend from s, 90,00 to s, 76,16, that extent laid the ſame way from s, 71,51 the complement altitude, will give s, 67 23 the complement declination, Hence the declination is 22.37 N, as required,

By Mr. MARTIN'S *Sliding Rule.*

Set s, 90,00 on the ſlider to s, 13,44 the ſun's azimuth on the rule; then againſt tangent 71,51 the complement altitude, on the ſlider you will have tangent 35,54 on the rule, the complement latitude required, The latitude is found equal 54,06,

For the ſun's declination,

Set s, 90,00 on the ſlider to s, 76,16 on the rule, then againſt 71,51 on the ſlide, you will have s. 67,23 on the rule, comp. declination; hence the declination is 22,37 N. as reqnired.

Problem 20th, The latitude of the place and the ſun's declination given, to find the ſun's altitude, and the hour of the day which is due eaſt or weſt,

Example, In the latitude 54,10 N, the ſun's declination being 23,29 N, Required the ſun's altitude aud hour of the day when he is due eaſt or due weſt,

Note, When the ſun is either eaſt or weſt, he is then upou the prime vertical Z A N,

In the rectangled triangle here described, we underſtand,
1ſt A *k l* the right angle
2d *k* A *l* the latitude of the place
3d *k l* the ſun's declination of the ſame name with the latitude
4th A *l* the altitude when eaſt or weſt,
5th A *k* the hour from ſix if eaſt, after ſix in the forenoon but weſt, if before ſix in the afternoon.

The Stereographical Projection.

Having drawn the premitive circle, and quartered it with two diameters, making S A B the horizon, and Z A N, the prime vertical, and make P A L, the axis of the world and Æ A Q, the equinoxial.

With the tangent of the complement of ſun's declination, deſcribe the parallel circle which cuts the prime vertical in the place of the ſun, at the time when due eaſt or weſt.

3d, Now having three points P *l k*, not ſituate in a right line, through which, to deſcribe an oblique circle, that cuts the equinoxial Æ A Q, at right angles in *k* which forms the rectangled triangle A *k l*, and it is done.

For the hypothenuſe, A *l* equal the ſun's altitude, A *k* equal the hour from ſix when he is either eaſt are weſt, was the two things required, and are both meaſured on the ſcale of half tangents.

But by Trigonometry. Having a leg and its oppoſite angle given, that is *k* A *l* 54 ,10 the latitude, and *k l* equal 23 ,29 the ſun's declination; the leg A *k* hour from ſix, and the hydothenuſe A *l* equal the ſun's altitude when eaſt or weſt, are found as follow. h,

Trigonometrical Proportions,

To find the Sun's Amplitude.

As s. latitude	54 ,10	9,908873
Is to s. ſun's declina.	23 ,29	9.600409
So is Radius	90 ,00	10,000000
To s. ſun's altiude	29 ,26	9,691536

To find the hour of the day.

As tangent latitude	54 ,10	10.141398
Is T. ſun's declination	23 ,29	9,637956
So is Radius	90 ,00	10,000000
To s. hour of the day	18 ,17	9,456558

Conſequently the ſun's altitude is 29 ,26

Convert 18 ,17 into time 5) 3 ,39 25
3

that is 1h. 13 min,

Which added to ſix hours, if in the forenoon 7 hours 13 minutes, on the afteronon ſubtract from 6 hours remains 4 hours 47 minutes, as was required.

In

Inſtrumentally by Scale and Compaſſes.

Extend from tangen 54 ,10 the latitude, to tangent 23 ,26 the ſun's declination, that extent laid the ſame way from s, 90 ,00 will give s, 18 ,17 the hour of the day when eaſt or weſt.

To find the ſun's altitude at the ſame time.

Extend from s, 54 ,10 to s, 23 ,29, that extent laid from s. 90 ,00 will give s, 29 ,26 the ſun's altitude required.

By MARTIN's *Sliding Rule.*

To find the hour when the ſun is due eaſt or weſt.

Set tangent 54 ,20 on the ſlider to tangent 23 ,29 on the rule, then againſt s. 90 ,00 on the ſlider you will have s. 18 ,17 on the rule, which converted into time is 1 hour 13 minutes the ſame as above

To find the ſun's altitude.

Set s. 54 ,10 on the ſlider to s, 23 ,29 on the rule, then againſt s, 90 ,00 on the ſlider you will have s, 29 ,26 on the rule the ſun's altitude as was required.

Problem 21ſt, *Suppoſe* the ſun due eaſt or weſt, the latitude of the place and altitude being given, to find the ſun's declination and hour of the day.

Example. In the latitude 54 ,10 N, the ſun being due eaſt, his altitude is 29 ,26; Required the ſun's declination and hour of the day at the ſame time.

Here is the hypothenuſe and one angle given, that is the hypothenuſe A *l* equal 29 ,26 the ſun's altitude, and the angle *k* A *l* equal 54 ,10 the latitude, [ſee the laſt figure] to find *k l* the ſun's declination, and A *k* equal the hour.

Trigonometrical Proportions.

To find the ſun's declination.			To find the Hour of the Day.	
As Radius,	90 ,00	10,000000		
Is to s. latitude	54,10	9,908873	As T. C, alt,	60 ,54
So is s, altitude	29 ,26	9,691445	Is to Radius	90 ,00
			So is s, c, lat.	35 ,50
To s, ſun's decli,	23 ,29	9,600318	To the T. hour	18 ,17

Here $\frac{18,17}{15}$ equal 1 hour 13 minutes, which added to 6 hours, makes 7 hours 13 min, forenoon, and 4h, 47 minutes afternoon.

In

Inſtrumentically by Scale and Compaſſes.

To find the hour of the Day.

Extend from tangent 54 ,10 the latitude, to tangent 23 ,29 the declination, that extent laid from s. 90,00 will give s. 18 ,17 the hour required. In time is 1 hour and 13 minutes.

To find the ſun's declination.

Extend from s, 90 ,00 to s, 54 ,10 the latitude, that extent laid the ſame way from s, 29 ,26 will give 23 ,29 the ſun's declination required.

By MARTIN'S *Sliding Rule,*

To find the hour of the day.

Set tangent 54 ,10 on the ſlider to tangent 23 ,29 on the rule; then againſt s. 90 .00 on the ſlider, you will have s. 18 ,17 on the rule; which converted into time is 1 hour 13 minutes.

To find the ſun's declination.

Set s. 90 .00 on the ſlider to s. 54 ,10 on the rule, then againſt s. 29 ,26 on the ſlider you will have s, 23 ,29 on the rule, the ſun's declination required.

Problem 22d, The ſun being upon the prime vertical, that is due eaſt or weſt; the latitude and hour of the day being given, to find the ſun's declination and altitude at that time.

Example, In the latitude of 30 ,10 N. the ſun comes upon the prime vertical 3 h. 15 m. P M. required his declination and altitude?

From	6h. 00m.	Then 2h. 45m. × 15 equal 41 .15 A *k* the hour (ſee figure)
Subſtract	3h. 15m.	
Remains	2h. 45m.	

Trigonometrical Proportions.

To find the ſun's declination,			For the ſun's altiude.		
A Radius	90 ,00	10,000000	As s. c. Lat.	59 ,50	9,936799
Is to s. hour	41 ,15	9,819813	Is to Radius	90 ,00	10,000000
So is T. lat,	30 ,10	9,764352	So is T. hour	41 ,15	9,942988
To T. dec.	20 ,58	9,583465	To tan. alt,	45 ,24	10,000189

In

Inſtrumentally by Scale and Compaſſes,

Extend from s. 90 ,00 to s, 41 15 the hour, that extent laid the ſame way from tangent 30 ,10 the latitude, will give tangent 20 ,58 the ſun's declination required.

To find the ſun's altitude.

Extend from s. 59 ,50 to s, 90 ,00, that extent laid from tangent 44 ,15 will give tangent 45 ,24 the ſun's altitude required.

By MARTIN's *Sliding Rule,*

To find the ſun's declination. Set s. 90 ,00 on the ſlider, to s. 41 15 on the rule; then againſt tangent 30 ,10 the latitude on the ſlider, you will have tangent 20 ,58 on the rule, the ſun's declination.

To find the ſun's altitude,

Set s. 59 ,50 the complement latitude, on the ſlider to s. 90 ,00 on the rule, then againſt tangent 41 ,15 the hour on the ſlider, you will have tangent 45 ,24 on the rule, the ſun's altitude required.

Problem 23d, The ſun due eaſt, his declination and altitude given, to find the latitude and hour of the day.

Example, Suppoſe the ſun's declination be 20 ,50 S. and his altitude 29 ,30, Required the latitude of the place, and hour of the day, when the ſun is due eaſt or weſt,

Here is given the hypothenuſe and one leg, that is the hypothenuſe A I, equal 29 ,30 the ſun's altitude, and *k b* the ſun's declination, equal 20 ,50, which triangle appears in the figure firſt given,

Trigonometrical Proportions.

To find the latitude of the place,			For the hour of the day.		
			As s. c, decl, 69 ,10		9,970635
As s, ſun's alt,	29 ,30	9,692339	Is to Radius	90 ,00	10,000000
Is to Radius	90 ,00	10,000000	So is s, c. alt.	60 ,30	9,639697
So is s, ſun's dec,	20,50	9,551024			
			To s, c. hour	68 ,38	9,969062
To the s, lat,	46 ,14	9,858685	Sub from	90 ,00	

Remains the hour 21 ,22, which converted into time, is 1 h. 25 m. which added to 6 h. 00 min. is 7 h. 25 min. A M. and the latitude of the place equal 46 ,14 N. as required,

In-

Inſtrumentally by ſcale and Compaſſes.

To find the Latitude.

Extend from s, 29 ,30 the ſun's altitude, to s. 90 ,00, that extent applied from s, 20 ,50 equal the ſun's declination, will give s, 46 ,14 the latitude required.

To find the hour of the day.

Extend from s. 69 ,10 the ſun's c. declination, to s. 90 ,00, that extent applied the ſame way from s, 60 ,30 the ſun's c, altitude, will give s, 68 ,38 the com. hour, and the hour 21 ,22 in time equal 1h, 25m.

Problem 24th, The ſun due weſt, his declination and hour of the day being given, to find the latitude and ſun's altitude,

Example. Suppoſe the ſun's declination 20 ,50 N. and the hour of the day 4h. 11m. Required the latitude of the place and the ſun's altitude of the ſame time.

From	6h. 00 m,	Then 1h. 49m. converted into degrees, make 27 ,15 degrees of the equinoxial,
Take	4 11	
Remains	1 49	

Trigonometrical Proportions.

To find the latitude of the place			To find the ſun's altitude.		
As Radius	90 ,00	10,000000	As Radius	90 ,00	10,000000
Is to s. hour	27 ,15	9,66746	Is to s. c, de,	69 ,10	9,970635
So is T. c. dec,	69,10	10,419611	So is s, c, hour	62 ,45	9,948910
To T. c, lat.	50 ,16	10,080357	To s, c. alt.	56 ,11	9,919545
Subſtract from	90 ,00		Subſtract from	90 ,00	
Rem. lat.	39 ,44		Rem. alt.	33 ,49	

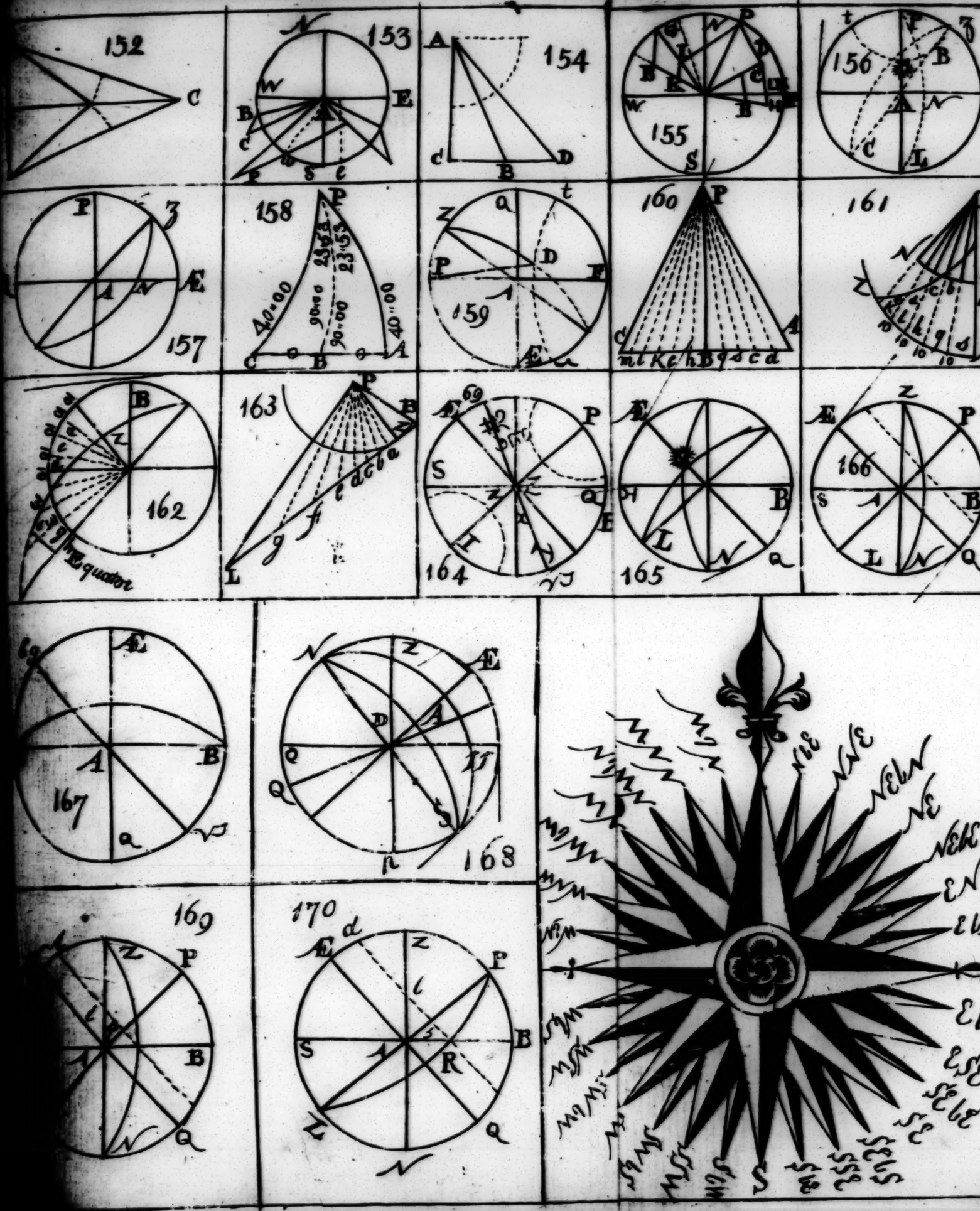
Inſtrumentally by Scale and Compaſſes.

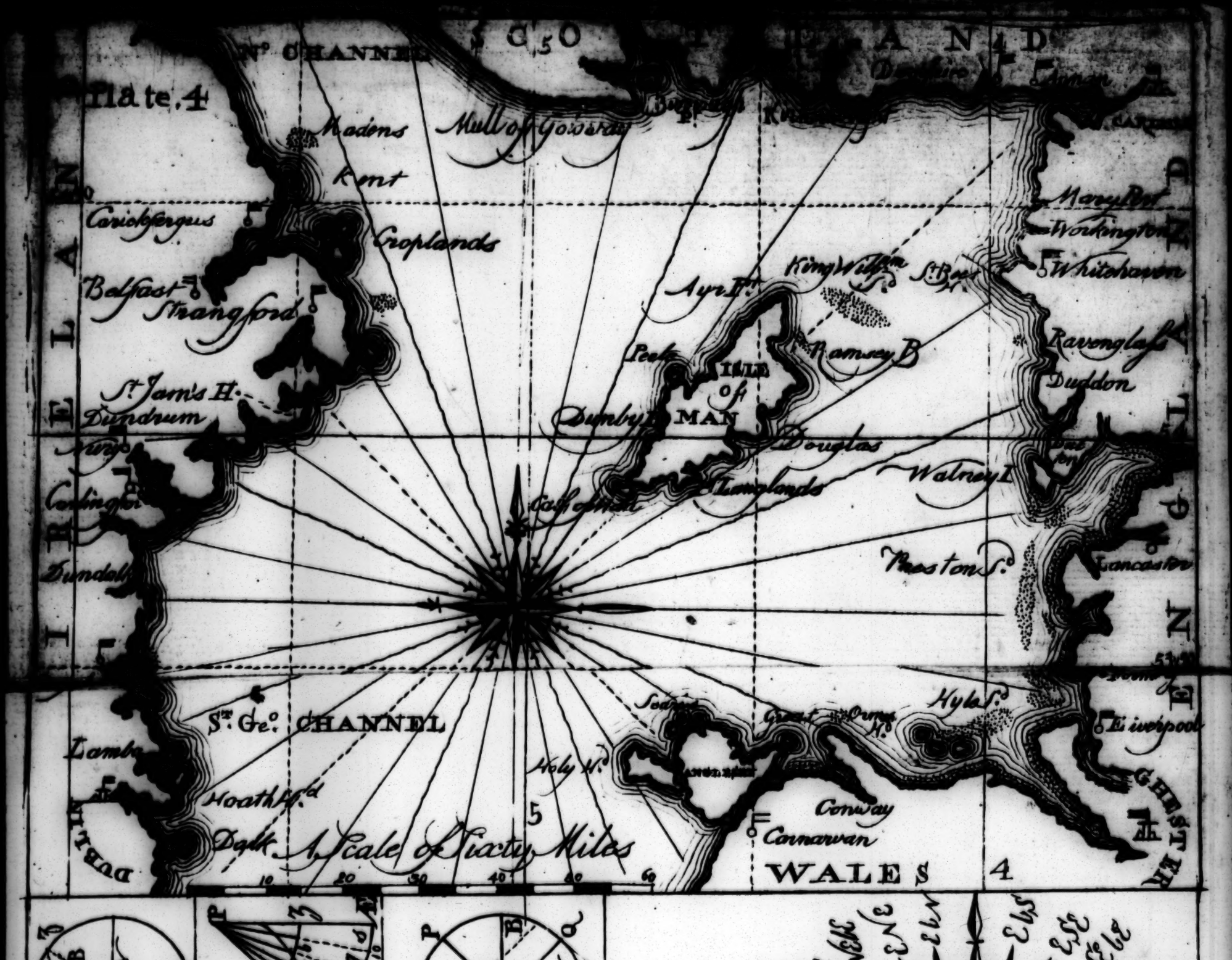
For the latitude. Extend from s. 90 ,00 to s. 27 ,15 the hour; that extent laid from tangent 69 ,10 ſun's declination, will give tangent 50 ,16 the comp. latitude, hence the latitude is 39 ,44 N.

To find the ſun's altitude.

Extend from s. 90 ,00 to s, 69 ,10 complement declination, that extent laid from 62 ,45, will give s, 56 ,11, the complement altitude, hence the ſun's altitude is equal 33 ,49, the ſame as before.

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90°00
40°00
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162
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Plate. 4
Nº CHANNEL
ENGLAND
IRELAND
Mull of Galloway
Kent
Carrickfergus
Croplands
Belfast
Strangford
Ayr Pt.
King Williams T.
St Bees
Whitehaven
Workington
Maryport
Ravenglass
Duddon
Peel
ISLE of MAN
Ramsey B
St Jam's H.
Dundrum
Douglas
Walney I
Lancaster
Preston
Hyle
Liverpool
St. Ge. CHANNEL
Holy H.
Conway
Carnarvan
WALES
Scale of Sixty Miles
10 20 30 40 50 60
5
4



By MARTIN'S *Sliding Rule,*

To find the latitude. Set s. 90 ,00 on the ſlider, to s. 27 ,15 the hour, on the rule ; then againſt tangent 69 ,10 equal co. declination on the ſlider, you will have tangent 50 ,16 on the rule, the com. latitude, from whence the latitude is equal 39 ,44 N.

To find the ſun's altitude,

Set s. 90 ,00 on the ſlider to s. 69 ,10 on the rule, then againſt 62 .45 the comp. hour on the ſlider, you will have s. 56 ,11 on the rule, the complement of ſun's altitude ; whence the altitude is equal 33 ,49 as was required.

Problem 25th. The ſun being due eaſt, his altitude and hour of the day being given, to find the latitude of the place and the ſun's declination at the ſame time.

Example, The ſun comes upon the prime vertical, at 7 hours 50 min. A M, at which time is altitude is 30 ,10; required the latitude of the place, and the ſun's declination at the ſame time,

Here 1 h. 50 m. × 15 equal 27 ,30 in degrees of the equinoxial.

Trigonometrical Proportions.

To find the latitude of the place,			To find the ſun's declination,		
As T. Radius	45 ,00	10,	As s, c. hour	62 ,30	9,947929
Is to T. hour	27 ,30	9,716777	Is to Radius	90 ,00	10,000000
So is s. c. alt,	59 ,50	9,936799	So is s, c. alt.	59 ,50	9,936799
To s. c. lat.	26 ,45	9,653576	To s. c, dec.	77 ,05	9,988870
Subſtract from	90 ,00		Subſtract from	90 ,00	
Rem. lat,	63 ,15	as required.	Rem. ſun's de.	12 ,55	as required.

Inſtrumentally by Scale and Compaſſes.

Extend from tangent 45 ,00 to tangent 27 ,30 that extent laid from s. 59,50 will give s. 26,45 the comp. latitude.

Extend from s, 62 ,30 to s, 90 ,00, that extent laid the ſame way from s, 59 ,50 will give s. 77 ,05 the s, co. ſun's declination required.

Problem 26th, The latitude of the place and the ſun's altitude, with the hour of the day being given, to find the ſun's azimuth and declination.

Example. Suppoſe the ſun's altitude be 39 ,55 in the latitude 33 ,29 north, and hour of the day 2 h. 51 min. 42 ,48; I deſire to know the ſun's declination and azimuth,

The Stereographical Projection.

Having deſcribed and quartered the premitive circle as before directed, ſet of the latitude 33 ,29 from O to N, and the axis of the world and the equinoxial through the center, make the angle O N Z equal 42 ,45 the hour converted into degrees, by multiplying 2 hours 15 min, by 15.

Draw a parallel to the horizon equal 50 ,05 equal complement of the ſun's altitude, diſtant from z, the zenith diſtance as z o, to cut the oblique circle N O s in O the place of the ſun at that time.

Through the points z O and N deſcribe an azimuth circle as z O N and its done.

Explanation of the Scheme.

In the oblique angled ſpherical triangle Z ſun N, is to be noted.

2, z o, the complement of the ſun's altitude.

1. z N repreſents the complement of latitude.

3. N O the ſun's diſtance from the elevated pole which is the ſum of the declination added to 90 00 when the latitude and declination are of contrary names but if one name as here in this example it is the complement of the declination.

4, O Z N the ſuns azimuth from the north in ſouth latitude, but from the ſouth in north latitude,

5, O N z, equal the hour of the day from noon.

6, Z the zenith, n the nader, N the north pole, S the ſouth pole, N A S the axis, Æ A Q the equinoxial or firſt azimuth of eaſt or weſt.

Trigonometrical Proportions.

39 ,55	33 ,29	2 hours 51 min. in
50 ,05 equal c. altitude	56 ,31 equal c. lat.	Degrees equal 42 ,45

To find the angle of poſition

		co. ar.
As S. C. ſun's alt,	50 ,05	0,115217
Is to s, hour A M.	42 ,45	9,831742
So is S. C. lat.	56 ,31	9,921190
To s. ∠ ſun's poſi.	47 ,34	9,868149

∠ ſun's poſition	47 ,34
∠ hour from noon	42 ,45
Sum of the angles	90 ,19
Difference of angles	4 ,49
Half difference of ∠s	2 ,24

Co.

Co. latitude	56 ,31			co. ar.
Co. altitude	50 ,05	As S. half × sides	3 ,16	1,244253
		Is to s. half Z sides	53 ,18	9,904053
Sum sides	106 ,36	So is T. half × ∠s	2 ,24	8, 22343
Half sum sides	53 ,18	To T. C. half contained angle	30 32	9,770649
× of sides	6 ,26			
Half diff. of sides	3 ,16	Then 90 ,00 — 30 ,32 equal 59 ,28 then 59 ,28 × 2 equal 118 ,56		

Then 180 00—118.56 equal 61.04 the sun's azimuth from south and 61.04 equal 5 points and a half or S E by E half E nearly.

To find the side N O, the sun's distance from the pole or complement declination.

As s. h, from noon	42 ,45	co. ar,	0,168258	From	90 ,00
Is to s. c. altitude	50 ,05		9,885578	Subtract	81 ,27
So is s. sun's azimuth	61 ,04		9,942094		
				Declination	8 ,33
To s. suns dist, from N. pole	81 ,47		0,995140		

Instrumentally by Scale and Compasses.

Extend from s, 53 ,05 to s, 42 ,45, that extent laid from s 56 ,31 will give s, 47 ,34 the angle of position.

Again, Extend from s. 3 ,06 (half the difference of the co. latitude and co. altitude is to the s. of half their sum 53 ,18 is the tangent 2 ,24) one third × of the angle of position, and hour angle from noon, tangent 30 ,32 equal the tangent com. half the sun's azimuth from from south, which subtracted from 90 ,00 contains 39 ,28 doubled is 118 ,66 hence the the sun's azimuth equal 51 ,04.

3dly, Extend from s, 42 ,45 to s, 50 ,05, that extent laid the same way from s, 69 ,04 the sun's azimuth will give s, 81 ,27 the sun's distance from the pole. Hence the declination is 8 .33 N, as required,

By MARTIN'S *Sliding Rule,*

Set s. 50 ,03 on the slider to s, 42 ,45 on the rule, then against s, 56 ,31 on the slider you will have s, 47 ,34 on the rule the angle of position.

Set s, 3 ,16 on the slider to s, 53 ,18 then against tangent 2 ,24 on the slider you will have tangent 30 ,32 on the rule; which gives the sun's azimuth 61 ,04,

3d. Set s, 42 ,45 on the slider to s, 50 ,05 on the rule, then against s. 61 ,04 on the slide, you will have s. 81 ,27 on the rule, which is the sun's distance from the pole, and declination 8 ,33 N.

Problem 27th, The latitude of the place and the ſun's declination given, together with the ſun's azimuth, to find his altitude, and hour of the day.

Example, Suppoſe the ſun's declination be 20 ,50 ſouth, and the ſun's azimuth 130 ,30 from the north in the latitude 30 ,51 N, required the ſun's altitude and hour of the day.

See the laſt projection in the oblique angled ſpherical triangle z O N, is given the ſide Z N equal 50 ,00 the complement latitnde, N O equal 110 ,30 the ſun's diſtance from the north pole, and its oppoſite angle O Z N equal 130 ,20 the azimuth, to find the ſide Z O. the complement altitude and angle O N Z equal the hour from noon.

Trigonometrical Proportions,

		co. ar.
As s. ſun's di, from s. pole	69,30	0,028412
Is to s, ſun's azimuth	49 ,30	9,881046
So is s. c. latitude	59 ,39	9,933747
To s. ∠ of poſition	44 .11	9,843208
		co. ar.
As s, half × of ſides	25 ,10	0,371353
Is to s. half Z ſides	84 .49	9,997732
So is T. × of angles	43 ,09	9,971835
To T. c, hours ∠	65 30	10,341020
Subſtracted from	90 00	
Remains	24 30	double equal 49 00

S. c, latitude	59 ,09
Sun's ſidec	110 ,30
Z of ſides	169 39
Difference of ſides	50 21
Half Z of ſides	84 49
Half × ef ſides	25 10
Angle O Z N	130 30
Angle N ſun Z	44 11
Z angles	174 41
× of angles	86 ,19
Half × of angles	43 09

Then 49 00 turned into time is 3 hours 16 minutes required

		co, ar,
As s, ∠ of poſition	44 11	0,156794
Is to s, c, latitude	59 ,09	9,933747
So is s, hour angle	49 ,00	9,877779
To s, c. altitude	68 ,23	9,968320

90 .00 — 68 ,23 equal 21 ,37 whence the hour of the day from noon is 3 hours 16 min. and altitude 21 ,37 as required.

Inſtrumentally by Scale and Compaſſes,

Extend from s, 69 ,30 to s. 49 ,30 that extent laid the ſame way from s, 59 ,39 will give s, 44 ,11 the angle of poſition,

Then

Then extend from s. 25 ,10 to s. 84 ,46 that extent laid the same way from tangent 43 ,09, gives tangent 65 ,30 which taken from 90 ,00 leaves 24 ,30 and douled is 49,00 in time is 3 hours 16 min. the hour of the day.

3dly, Extend from s, 44 11 to s, 59 09 so is s, 49 00 to s, 68 23 whose complement 21 37 is the sun's altitude required,

Problem 27th, Having the latitude of the place, the sun's declination and hour of the day given, to find the sun's altitude and azimuth at that time.

Example. In the latitude 20 ,11 north the sun's declination 23 ,29 south, and hour of the day 9 hours 24 min, forenoon, or 2 hours 36 afternoon, required the sun's azimuth altitude and angle of position.

See the last stereographic projection.

Trigonometrical Proportions:

Side NO	113 ,29		∠ Z NO	39 ,00	70 ,30
Side N Z	69 49				88 ,21
Z sides	183 18	Half Z 91,39	Half	19 ,30	
			Complement		68 ,10
× sides	43 40	Half × 21,50			

		co, ar,
As s. half sum sides	88 ,21	0,000180
Is to s, half × sides	21 ,50	9,570436
So is T, ∈, half con. ∠	70 ,30	10,450851
To T, C, half × of ∠s	46 25	0,021467

		co, ar,
As s, C. half Z sides	1 ,39	1,545107
Is to s. c, half × sides	68 10	9,96767
So is T. C. half con. ∠s	70 30	10,450851
To the T. half the sum	89 23	11,963632

Half Z angle	89 ,23
Half × of angles	46 28
Great angle	135 57
Lesser angle	42 58

Angle O Z N equal 135 ,51 is the sun's azimuth from the N. and angle N O Z 42 ,58 the angle of positon; the answer required.

Problem 28th, Having the latitude of the place, the sun's azimuth and hour of the day given, to find the sun's declination, altitude, and the angle of the sun's position.

Example. In the latitude 13 10 N, the sun's azimuth is 135 ,51 from the north, and hour of the day equal 2 hours 36 minutes in the after-

aſcenncon; required the ſun's declination, altitude, and angle of poſition.

See the laſt ſtereographic projection,

Trigonometrical Proportions.

∠ O z N	135 ,51		Side z N	76 50	51 35
∠ O N z	39 00				
Z of ∠s	174 51	Half Z 87 25	Half thereof	38 25	2 35
			Complement		41 35
× of angles	96 51	Half × 48 25			

		co. ar.		
			Half ſum angles	85 ,07
As s, half z angles	87 ,25	0,000442	Half × of angles	30 45
Is to s, half × of angles	48 25	9,87 ;897		
So is T. half given ſide	38 28	9,900087	Greater ſide	115 52
To T, half × of ſides	30 ,45	9,774426	Leſſer ſide	59 22
		co. ar.		
As s, c. half z angles	2 ,35	1,346426	As s, c. altitude	54 ,22
Is to s, c. half × angles	41 39	9,821978	Is to s hour	39 00
So is T, half ſide z N	38 28	9,,00087	So is s. c. lat.	76 50
			To s, ∠ of poſ.	41 04
To T. half ſum ſides	85 07	11,068 54		

Hence the ſun's altitude is 54 22, ſun's declination equal 23 ,29 and ſun's angle of poſition 41 04.

Problem 26th, Having the ſun's declination, his altitude and azimuth given; to find the latitude of the place, and hour of the day from noon,

Example, Suppoſe the ſun's declination be 19 12 N. and the ſun's altitude be 29 30, and the ſun's azimuth 130 00; I deſire to find the latitude of the place, hour of the day from noon, and angle of the ſun's poſition.

See problem 34th In the oblique angled triangled ſpherical triangle z ſun N, is given N ſun equal the ſun's diſtance from the north pole equal 70 48, z ſun the complement altitude equal 50 30, and the angle ſun z N equal 130 ,00 the azimuth from north or 50 00 from S, to find the angle O N z, the hour from noon, ſide N z the complement latitude, and angle z ſun N the angle of poſition.

Since this problem is of excellent uſe to the Navigator where he may take an obſervation at any time of the day; I ſhall here ſhew the work

in

in as plain and eaſy a method as is poſible, to find the latitude of the place both inſtrumentally and logarithmetically.

Trigonometrical Proportions,

As Radius	90 ,00	10,000000
Is to s. c, ſun az. from mer.	40,00	9,808067
So is T. C. altitude	50 30	10,083895
To tangent 4th arch	37 57	9,891962
		co. ar.
Then As s. ſun's altitude	36 30	0,196490
Is to s. c. 4th arch	52 03	9,896828
So is s. ſun's declination	19 ,11	9.517020
To s, c. 5th arch	24 03	9,610338

From	90 ,00
Subſtract from	24 ,03
Fifth arch	65 ,57
Fourth arch	37 57
Co. latitude	28 00

Hence the latitude is 62 ,00 N.

Inſtrumentally by Scale and Compaſſes.

Extend from s. 90 ,00 to s. 40 00 the s, c. azimuth, that extent laid from T. C, altitude 30 30 will give tangent 37 57 a fourth arch.

Then extend from s. ſun's altitude 39 30 to s. c. fourth arch 52 ,03 that extent laid from s, ſun's declination 19 ,12 will give s. 24 ,03 the complement of the 5th arch equal 65 57. from which ſubtract fourth arch 37 ,57 and there remain, 28 ,00 the complement latitude, hence the latitude is 62 ,00.

By Mr. MARTIN's *Sliding Rule.*

Set s. 90 ,00 on the ſlider to s, 40 ,00 the s. c, azimuth on the rule, then againſt tangent 50 30 the T. C. altitude on the ſlider you will have tangent 37 .57 on the rule the fourth arch.

Then ſet s. 30 ,30 on the ſlider to 52 ,03 the s. c. fourth arch on the rule, then againſt s, 19 ,12 the ſun's declination on the ſlider you will have 24 03 on the rule, the S. co. fifth arch which taken from 90 ,00 gives 65 57, and 65 ,57 — 37 ,57 equal 28 ,00 equal complement latitude, hence latitude equal 62 ,00 N, as was required.

To find the Hour of the Day

		co. ar.
As s. c. ſun's declination	70 ,48	0,024855
Is to s. ſun's azimuth	50 ,00	9,884254
So is s. c. ſun's altitude	50 ,30	9,887406
To s. hour angle	38 ,45	9,796515

Aangle 38 ,45 converted into time thus.

5)38 ,45

3) 7 ,15

2 ,35

Hence the time from noon is 2 h, 35 m. that is 25 min. paſt 10 o'clock forenoon or 35 min, paſt 2 afternoon.

To

To find the angle of Poſition. The Proportions.

		co, ar,	Anſwer.
As s. c. ſun's dec.	70 ,48	0,024855	Latitude 62 ,00
Is s. ſun's azimuth	50 00	9,884254	Hour from noon 2 hours
So is s. c. latitude	28 ,00	9,671609	35 minutes
To s. angle of poſition	22 ,23	9,550718	Angle of poſition 22,23

Problem 30th. Given two unequal altitudes of the ſun taken on the ſame day, and the time between the obſervations, together with the ſun's declination, to find the latitude of the place.

Example. Suppoſe the ſun's declination be 20 ,14, and ſome time on the forenoon we took the ſun's altitude which was 43 ,07, and two hours after we took the ſun's altitude which was 56 .34; Required the latitude of the place and hour of the day.

Solution. Sun's declination equal 20 ,14 his diſtance from the pole is 69,46; Then in the right angled tringle ABN, are given the hypothenuſe AN equal 69,46 equal complement declination, the angle AN *b* equal 15 ,00 equal half time between obſervations, to find the ſide A *b*, thus,

Trigonometrical Proportions.

As Radius	90 ,00	10,000000	3d. In the oblique triangle DNA are given the two ſides viz, D A, equal 28 ,06, DN equal 69 ,46, and the angle oppoſite D N A equal 30 ,00 deg.
Is to s. ſide A N	69 ,46	9,972338	
So is s. angle BNA	15 ,00	9,422996	
To the ſide *b* A	14 ,03	9,385334	
	14 ,03		
Doubled is ſide AD	28 ,06		

To find the other oppoſite angle DAN.

As s. c. ſide A D		28 ,06	3d. In the oblique angled Δ DAZ there is given three ſides Z A equal 33 ,26 equal complement great altitude, Z D equal 46 ,54 equal complement leſſer altitude, and AD equal 28 ,06. To find the angle DAZ.
Is to s, oppoſite ∠	AND	30 ,00	
So is ſide ND		69 ,46	
To s. angle D A N		84 ,58	

Side

Side Z A 33 ,26	Containing sides	33 .26	co. ar.	0,258855
Side D A 28 ,06		28 ,06	co, ar.	0,326968
Side D Z 46 ,54	Half sum o sides S.	54 ,13		9,909146
	Remainde	7 ,19		9,105009
Z sides 105 ,26				
	Sum of these Logarithms			19,599998
Half Z 52 .13				
	Half sum is	39 ,07		9,799997
Reman 7 ,19				
	Half angle	50 ,53	doubled is	101 ,46

Hence the angle DAZ equal 101 ,46, from which subſtract angle DAC 84 ,56, and there remains 16 ,48 equal angle NAZ.

Inſtrumentally by Scale and Compaſſes.

Firſt, extend from s. 90 ,00 to s. 33 ,26, that extent laid the ſame way from 28 ,06, will give 15 ,08 a 4th line,

2d. Extend from s. 15 ,03 to s. 54 ,15 half ſum of ſides, that extent laid the ſame way from 7 ,11 will give 23 ,28, againſt which in verſed lines is 104 ,46

From which ſubſtract angle DAN 84 ,58

Remains angle NAZ 16 ,48

4th. In the oblique triangle NAZ are given the two ſides NA 69 ,46 the ſun's diſtance from the pole; AZ equal 32 ,26 the complement greater altitude, alſo the angle contained 16 ,48. To find the azimuth from north the angle ZAM, and angle ANZ equal the hour from noon, and ZN the complement latitude of the ſhip.

Side NA 69 ,46			
Side ZA 33 ,26	Half ſum 51 ,36	∠ NAZ 16 ,48	
103 ,12	Half × 18 ,10	Com. 8 ,24	81 .36
36 ,20			38 .24
			71 .50

As s. half ſum of ſides	51 .36 co. ar.	0,105854	84 ,29
Is to s. half × of ſides	18 ,10	9,493851	69 ,38
So is tang. co. half contained Δ	18 ,36	10,830716	
			154 ,07
To tangent half × angles	69 ,38	10,430421	Azc. from N.

As s. c. half ſum of ſides	38 ,24	co. ar.	0.206805	84 ,29
Is to s. c. half ✕ of ſide	71 ,56		9,977794	69 ,34
So is tan. half con. ∠	81 ,36		10,830916	14 ,55
To the tang. half ſum of ang.	84 ,29		11,015315	hour from noon

Hence it is evident that the Azimuth A Z N equal 154 ,07 alſo the hour angle ZNA equal 14 ,55, which turned into time is 59 m. 30 ſec. neareſt or 30 ſeconds paſt a 11 o'clock, the time of the ſecond obſervation.

As s. hour ang.	14 ,55	co. ar.	0.589368	From	90 .00
Is to s. c. altitude	33 ,26		9,741128	Subſtract	38 ,73
So is s. ſun ang. of poſ.	16 ,48		9,460946	Remain lat.	51 ,47
To s, c, latitude	38 ,13		9,791439		

A large

A large and useful

TABLE

OF

DIFFERENCE

OF

Latitude and *Departure*,

IN

Minutes and Tenth Parts,

TO

Every *Degree* and *Quarter Point*

OF THE

COMPASS,

For the exact Working of a

TRAVERSE;

And readily finding the Longitude by Inspection,
According to

Middle Latitude.

Dist.	1 Deg.		2 Deg.		1 q. Pt.		3 Deg.		4 Deg.		5 Deg.		Dist.
	Lat.	dep.	Lat	dep.	Lat.	dep.	Lat	dep	Lat.	dep,	Lat	dep,	
1	01,0	00,0	01,0	00,0	01,0	00,0	01,0	00,1	01,0	00,1	01,0	00,1	1
2	02 0	00 0	02 0	00,1	02 0	00,1	02 0	00 1	02 0	00 1	02 0	00 2	2
3	03 0	00 1	03 0	00,1	03 0	00,1	03 0	00 2	03 0	00 2	03 0	00 3	3
4	04 0	00 1	04 0	00,1	04 0	00,2	04 0	00 2	04 0	00 3	04 0	00 3	4
5	05 0	00	05 0	00,2	05 0	00,2	05 0	00 3	05 0	00 3	05 0	00 4	5
6	06,0	00,1	06,0	00,2	06,0	00,3	06,0	00,3	06,0	00,4	06,0	00,5	6
7	07 0	00	07 0	00 2	07 0	00,3	07 0	00 4	07 0	00 5	07 0	00 6	7
8	08 0	00 1	08 0	00 3	08 0	00,4	08 0	00 4	08 0	00 6	08 0	00 7	8
9	09 0	00 2	09			00 4	09 0	00 5	09 0	00 6	09 0	00 8	9
10	10 0	00 2	10 0			00,5	10 0	00 5	10 0	00 7	10 0	00 9	10
11	11,0	00,2	11,0	00,4		00,5	11,0	00,6	11,0	00,8	11,0	01,0	11
12	12 0	00 2	12 0	00	12 0	00,6	12 0	00 6	12 0	00,8	12 0	01 0	12
13	13 0	00 2	13 0	00 5	13 0	00,6	13 0	00 7	13 0	00,9	12 9	01 1	13
14	14 0	00 2	14 0	00 5	14 0	00,7	14 0	00 7	14 0	01,0	13 9	01 2	14
15	15 0	00 3	15 0	00 5	15 0	00 7	15 0	00 8	15 0	01,0	14 9	01 3	15
16	16,0	00,3	16,0	00,6	16,0	00,8	16,0	00,8	16,0	01,1	15,9	01,4	16
17	17 0	00 3	17 0	00 6	17 0	00 8	17 0	00 9	17 0	01,2	16 9	01 5	17
18	18 0	00 3	18 0	00 6	18 0	00 9	18 0	00 9	18 0	01,3	17 9	01 6	18
19	19 0	00 3	19 0	00 7	19 0	00 9	19 0	01 0	19 0	01,3	18 9	01 7	19
20	20 0	00 4	20 0	00 7	20 0	01 0	20 0	01 0	20 0	01,4	19 9	01 7	20
21	21,0	00,4	21,0	00,7	21,0	01,0	21,0	01,1	20,9	01,5	20,9	01,8	21
22	22 0	00 4	22 0	00 8	22,0	01 1	22 0	01 1	21 9	01,5	21 9	01 9	22
23	23 0	00 4	23 0	00 8	23,0	01 1	23 0	01 2	22 9	01,6	22 9	02 0	23
24	24 0	00 4	24 0	00 8	24,0	01 2	24 0	01 3	23 9	01,7	23 9	02 1	24
25	25 0	00 4	25 0	00 9	25,0	01 2	25 0	01 3	24 9	01,7	24 9	02 2	25
26	26,0	00,5	26,0	00,9	26,0	01,3	26,0	01,4	25,9	01,8	25,9	02,3	26
27	27 0	00,5	27 0	00 9	27,0	01 3	27 0	01 4	26 9	01 9	26 9	02 4	27
28	28 0	00,5	28 0	01 0	28,0	01 4	28 0	01 5	27 9	02 0	27 9	02 4	28
29	29 0	00,5	29 0	01 0	29,0	01 4	29 0	01 5	28 9	02 0	28 9	02 5	29
30	30 0	00,5	30 0	01 1	30,0	01 5	30 0	01 6	29 9	02 1	29 9	02 6	30
31	31,0	00,5	31,0	01,1	31,0	01,5	31,0	01,6	30,9	02,2	30,9	02,7	31
32	32 0	00,6	32 0	01 1	32,0	01 6	32 0	01 7	31 9	02 2	31 9	02 8	32
33	33 0	00,6	33 0	01 2	33,0	01 6	33 0	01 7	32 9	02 3	32 9	02 9	33
34	34 0	00,6	34 0	01 2	34,0	01 7	34 0	01 8	33 9	02 4	33 9	03 0	34
35	35 0	00,6	35 0	01 2	35,0	01 7	35 0	01 8	34 9	02 4	34 9	03 1	35
36	36,0	00,6	36,0	01,3	36,0	01,8	35,9	01,8	35,9	02,5	35,9	03,1	36
37	37 0	00 6	37 0	01 3	37,0	01 8	36 9	01 9	36 9	02 6	36 9	03 2	37
38	38 0	00 7	38 0	01 3	38,0	01 9	37 9	02 0	37 9	02 7	37 9	03 3	38
39	39 0	00 7	39 0	01 4	39,0	01 9	38 9	02 0	38 9	02 7	38 9	03 4	39
40	40 0	00 7	40 0	01 4	40,0	02 0	39 9	02 1	39 9	02 8	39 8	03 5	40
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	89 Deg.		88 Deg.		87 Deg.		87 Deg		86 Deg.		85 Deg.		



Dist.	1 Deg.		2 Deg,		1 q. Pt.		3 deg,		4 deg.		5 Deg.		Dist.
	Lat.	dp.	Lat.	dp.	Lat,	dep.	Lat,	dep.	Lat,	dep,	Lat,	dep.	
41	41,0	0.7	41,0	1,4	40.0	02,0	40,9	02.1	40,9	02,9	40,8	03.6	41
42	42 0	07	42 0	1 5	41 9	02 1	41 9	02 2	41 9	02 9	41 8	03 7	42
43	43 0	08	43 0	1 5	42 9	02 1	42 9	02 2	42 9	03 0	42 8	03 8	43
44	44 0	08	44 0	1 5	43 9	02 2	43 9	02 3	43 9	03 1	43 8	03 8	44
45	45 0	08	45 0	1 6	44 9	02 2	44 9	02 4	44 9	03 1	44 8	03 9	45
46	46 0	08	46 0	1 6	45 9	02 3	45 9	02 4	45 9	03 2	45 8	04 0	46
47	47 0	08	47 0	1 6	46 9	02 3	46 9	02 5	46 9	03 3	46 8	04 1	47
48	48 0	08	48 0	1 7	47 9	02 4	47 9	02 5	47 9	03 4	47 8	04 2	48
49	49 0	09	49 0	1 7	48 9	02 4	48 9	02 6	48 9	03 4	48 8	04 3	49
50	50 0	09	50 0	1 7	49 9	02 5	49 9	02 6	49 9	03 5	49 8	04 4	50
51	51,0	0,9	51.0	1 8	50,9	02,5	50,9	02.7	50,9	03,6	50,8	04.4	51
52	52 0	09	52 0	1 8	51 9	02 6	51 9	02 7	51 9	03 6	51 8	04 5	52
53	53 0	09	53 0	1 8	52 9	02 6	52 9	02 8	52 9	03 7	52 8	04 6	53
54	54 0	09	54 0	1 9	53 9	02 7	53 9	02 8	53 9	03 8	53 8	04 7	54
55	55 0	10	55 0	1 9	54 9	02 7	54 9	02 8	54 9	03 8	54 8	04 8	55
56	56 0	10	56 0	2 0	55 9	02 7	55 9	02 9	55 9	03 9	55 8	04 9	56
57	57 0	10	57 0	2 0	56 9	02 8	56 9	03 0	56 9	04 0	56 8	05 0	57
58	58 0	10	58 0	2 0	57 9	02 8	57 9	03 0	57 9	04 0	57 8	05 1	58
59	59 0	10	59 0	2 1	58 9	02 9	58 9	03 1	58 9	04 1	58 8	05 1	59
60	60 0	10	60 0	2 1	59 9	02 9	59 9	03 1	59 9	04 2	59 8	05 2	60
61	61,0	,0	61.0	2,1	60.9	03,0	60.9	03,2	60,9	04,3	60,8	05,3	61
62	62 0	10	62 0	2 2	61 9	03 0	61 9	03 2	61 9	04 3	61 8	05 4	62
63	63 0	10	63 0	2 2	62 9	03 1	62 9	03 3	62 9	04 4	62 8	05 5	63
64	64 0	10	64 0	2 2	63 9	03 1	63 9	03 3	63 8	04 5	63 8	05 6	64
65	65 0	10	65 0	2 3	64 9	03 2	64 9	03 4	64 8	04 5	64 8	05 7	65
66	66 0	11	66 0	2 3	65 9	03 2	65 9	03 5	65 8	04 6	65 7	05 8	66
67	67 0	11	67 0	2 3	66 9	03 3	66 9	03 5	66 8	04 7	66 7	05 8	67
68	68 0	11	68 0	2 4	67 9	03 3	67 9	03 6	67 8	04 7	67 7	05 9	68
69	69 0	11	69 0	2 4	68 5	03 4	68 9	03 6	68 8	04 8	68 7	06 0	69
70	70 0	11	70 0	2 4	69 9	03 4	69 9	03 7	69 8	04 9	69 7	06 1	70
71	71,0	1,2	71,0	2,5	70,9	03,5	70,9	03,7	70,8	05,0	70,7	06.2	71
72	72 0	13	72 0	2 5	71 9	03 5	71 9	03 8	71 8	05 0	71 7	06 3	72
73	73 0	13	73 0	2 5	72 9	03 6	72 9	03 8	72 8	05 1	72 7	06 4	73
74	74 0	13	74 0	2 6	73 9	03 6	73 9	03 9	73 8	05 2	73 7	06 5	74
75	75 0	13	75 0	2 6	74 9	03 7	74 9	03 9	74 8	05 2	74 7	06 5	75
76	76 0	13	76 0	2 7	75 9	03 7	75 9	04 0	75 8	05 3	75 7	06 6	76
77	77 0	13	77 0	2 7	76 9	03 8	76 9	04 0	76 8	05 4	76 7	06 7	77
78	78 0	14	78 0	2 7	77 9	03 8	77 9	04 1	77 8	05 4	77 7	06 8	78
79	79 0	14	79 0	2 8	78 9	03 9	78 9	04 1	78 8	05 5	78 7	06 9	79
80	80 0	14	80 0	2 8	79 9	03 9	79 9	04 2	79 8	05 6	79 7	07 0	80
Dist.	dep.	L.	dep.	L,	dep.	Lat.	dep,	Lat,	dep,	Lat,	dep.	Lat.	Dist.
	89 Deg.		88 Deg,		7. 39. P,		87 deg,		86 deg,		85 Deg,		

Dif.	1 Deg.		2 deg.		1 q, Pt,		3 Deg		4 Deg.		5 Deg,		Dif.
	Lat,	dp,	Lat,	dp.	Lat	dp,	Lat,	dp.	Lat,	dp,	Lat	dep,	
81	81.0	1.4	81.0	2,8	80,9	4,0	80,9	4.2	80,8	5.7	80,7	7,1	81
82	82 0	1 4	81 9	2 9	81 9	4 0	81 9	4 3	81 8	5 7	81 7	7 2	82
83	83 0	1 5	82 9	2 9	82 9	4 1	82 9	4 3	82 8	5 8	82 7	7 3	83
84	84 0	1 5	83 9	2 9	83 9	4 1	83 9	4 4	83 8	5 9	83 7	7 3	84
85	85 0	1 5	84 9	3 0	84 9	4 2	84 9	4 4	84 8	5 9	84 7	7 4	85
86	86 0	1 5	85 9	3 0	85 9	4 2	85 9	4 5	85 8	6 0	85 7	7 5	86
87	87 0	1 5	86 9	3 0	86 9	4 3	86 9	4 6	86 8	6 1	86 7	7 6	87
88	88 0	1 5	87 9	3 1	87 9	4 3	87 9	4 6	87 8	6 2	87 7	7 7	88
89	89 0	1 6	88 9	3 1	88 9	4 4	88 9	4 7	88 8	6 2	88 7	7 8	89
90	90 0	1 6	89 9	3 1	89 9	4 4	89 9	4 7	89 8	6 3	89 7	7 9	90
91	91,0	1,6	90.9	3,2	90,9	4,5	90.9	4.8	90.8	6.4	90,7	8,0	91
92	92 0	1 6	91 9	3 2	91 9	4 5	91 9	4 8	91 8	6 4	91 7	8 0	92
93	93 0	1 6	92 9	3 2	92 9	4 6	92 9	4 9	92 8	6 5	92 7	8 1	93
94	94 0	1 6	93 9	3 3	93 9	4 6	93 9	4 9	93 8	6 6	93 7	8 2	94
95	95 0	1 7	94 9	3 3	94 9	4 7	94 9	5 0	94 8	6 6	94 6	8 3	95
96	96 0	1 7	95 9	3 4	95 9	4 7	95 9	5 0	95 8	6 7	95 6	8 4	96
97	97 0	1 7	96 9	3 4	96 9	4 8	96 9	5 1	96 8	6 8	96 6	8 5	97
98	98 0	1 7	97 9	3 4	97 9	4 8	97 9	5 1	97 8	6 9	97 6	8 6	98
99	99 0	1 7	98 9	3 5	98 9	4 9	98 9	5 2	98 8	6 9	98 6	8 7	99
100	100 0	1 7	99 9	3 5	99 9	4 9	99 9	5 2	99 8	7 0	99 6	8 7	100
101	101,0	1,8	101,0	3.6	100.9	5.0	100,9	5.3	100.8	7,1	100,6	8.8	101
102	2 0	1 8	2 0	3 6	1 9	5 0	1 9	5 3	1 8	7 2	1 6	8 8	102
103	3 0	1 8	3 0	3 7	2 9	5 1	2 9	5 4	2 8	7 2	2 6	8 9	103
104	4 0	1 8	4 0	3 7	3 9	5 1	3 9	5 4	3 8	7 3	3 6	9 0	104
105	5 0	1 9	5 0	3 8	4 9	5 2	4 9	5 5	4 8	7 4	4 6	9 1	105
106	6 0	1 9	6 0	3 8	5 9	5 2	5 9	5 5	5 8	7 4	5 6	9 2	106
107	7 0	1 9	7 0	3 9	6 9	5 2	6 8	5 5	6 8	7 5	6 6	9 3	107
108	8 0	1 9	8 0	3 9	7 9	5 3	7 8	5 6	7 8	7 5	7 6	9 4	108
109	9 0	1 9	9 0	3 9	8 9	5 3	8 8	5 6	8 7	7 6	8 6	9 5	109
110	110 0	1 9	110 0	3 9	110 0	5 4	109 8	5 6	109 7	7 6	109 6	9 6	110
111	111,0	2.0	111,0	4.0	110.9	5,4	110.8	5,7	110.7	7.7	110.6	9.7	111
112	2 0	2 0	2 0	4 0	1 9	5 5	1 8	5 7	1 7	7 7	1 6	9 7	112
113	3 0	2 0	3 0	4 0	2 9	5 5	2 8	5 8	2 7	7 8	2 6	9 8	113
114	4 0	2 1	4 0	4 0	3 9	5 6	3 8	5 8	3 7	7 9	3 6	9 9	114
115	5 0	2 1	5 0	4 1	4 9	5 6	4 8	5 8	4 7	8 0	4 6	10 0	115
116	6 0	2 1	6 0	4 1	5 9	5 7	5 8	5 9	5 7	8 0	5 6	10 1	116
117	7 0	2 1	7 0	4 1	6 9	5 7	6 8	5 9	6 8	8 1	6 6	10 2	117
118	8 0	2 1	8 0	4 1	7 9	5 7	7 8	5 9	7 8	8 1	7 6	10 3	118
119	9 0	2 2	9 0	4 1	8 9	5 8	8 8	5 9	8 8	8 1	8 5	10 4	119
120	120 0	2 2	120 0	4 1	120 9	5 8	119 8	6 0	119 8	8 1	119 5	10 4	120
Dif.	dep,	L.	dep.	L.	dep,	L.	dep.	L,	dep.	L.	dep,	Lat,	Dif.
	89 Deg.		88 deg.		7. 39, Pt.		87 Deg,		86 Deg.		85 Deg.		

Dist.	1 deg		2 deg.		1 half P		3 Deg,		4 Deg,		5 Deg,		Dist.
	Lat.	dep,	Lat,	dep,	Lat,	dep,	Lat.	dep	Lat,	dep,	Lat,	dep,	
121	121,0	2,2	121.0	4,4	120,9	5,8	120.7	8,0	120.6	8,2	120,5	10,0	121
122	20	22	2	41	1	5,8	17	61	16	82	15	106	122
123	30	22	30	41	25	[illegible]	2	61	26	83	25	107	123
124	40	22	39	43	39	[illegible]	3	65	37	86	35	105	124
125	50	22	4	44	49	61	48	65	47	87	45	109	125
126	60	22	59	44	5	62	58	66	57	89	55	110	126
127	70	22	69	44	6	62	68	66	67	89	65	110	127
120	80	22	7	45	78	62	78	68	77	89	75	111	128
129	90	22	8	45	88	63	88	68	87	89	85	112	129
130	130	02	12	46	129	64	129	68	129	90	129	112	130
131	131,0	2,3	130,9	4,6	130,8	6,4	130.8	6,9	130,7	9,1	130,5	11,4	131
132	20	23	19	47	18	65	18	69	17	92	15	115	132
133	30	23	29	47	28	65	28	70	27	93	25	116	133
134	40	23	39	47	38	66	38	70	37	93	35	117	134
135	50	23	49	47	48	66	48	71	47	94	45	117	135
136	60	24	59	48	58	67	58	71	57	95	55	118	136
137	70	24	69	48	68	67	68	72	67	95	65	119	137
138	80	24	79	48	78	68	78	72	77	96	75	120	138
139	90	24	89	48	88	69	88	73	87	97	85	121	139
140	140	02	139	49	139	69	139	73	139	98	139	122	140
141	141,0	2,4	140.9	4,9	140,8	8.9	140	7.4	140,7	9,8	140.5	12,3	141
142	20	25	19	50	18	70	18	74	17	99	15	124	142
143	30	25	29	50	28	70	24	75	27	100	25	[illegible]4	143
144	40	25	39	50	38	71	38	75	37	100	35	125	144
145	50	25	49	51	48	71	48	76	47	101	44	126	145
146	60	25	59	51	58	72	58	76	56	102	54	127	146
147	70	25	69	51	68	72	68	77	66	102	64	128	147
148	80	26	79	52	78	73	78	77	76	103	74	129	148
149	90	26	89	52	88	73	88	78	86	104	84	130	149
150	150	02	149	53	149	74	149	79	149	105	149	131	150
151	151,0	2.6	150,	5,3	150,8	7.4	150.8	7.9	150,6	10,5	150,4	13,1	151
152	20	26	19	53	18	75	18	80	16	106	14	132	152
153	30	27	29	54	28	75	28	80	26	106	24	133	153
154	40	27	39	54	38	76	38	81	36	107	34	134	154
155	50	27	49	55	48	76	48	81	46	108	44	135	155
156	60	27	59	55	58	77	58	82	56	109	54	136	156
157	70	27	69	55	68	77	68	82	66	109	64	137	157
158	80	27	79	55	78	78	78	83	76	110	74	137	158
159	90	27	89	56	88	78	88	83	86	111	84	138	159
160	160	02	159	56	159	79	159	84	159	112	159	139	160
Dist.	dep,	L,	dep.	L,	dep,	L,	dep.	L.	dep,	Lat	dep,	Lat,	Dist.
	89 deg.		88 deg,		7. 39. P.		87 Deg,		86 Deg,		85 Deg.		

Diff.	1 D. Pnt.		6 Deg.		7 Deg.		8 Deg.		39. Pnt,		9 Deg.		Diff.
	Lat.	deg.	Lat,	dep.	Lat.	dep.	Lat.	dep	Lat.	dep,	Lat.	dep,	
1	01,0	00,1	01,0	00,1	01,0	00,1	01,0	00,1	01,0	00,1	01,0	00,2	1
2	02 0	00 2	02 0	00,2	02 0	00,2	02 0	00 3	02 0	00 3	02 0	00 3	2
3	03 0	00 3	03 0	00,3	03 0	00,4	03 0	00 4	03 0	00 4	03 0	00 5	3
4	04 0	00 4	04 0	00,4	04 0	00,5	04 0	00 6	04 0	00 6	03 9	00 6	4
5	05 0	00,5	05 0	00,5	05 0	00,6	05 0	00 7	04,9	00 7	04 9	00 8	5
6	06,0	00 6	06,0	00,6	06,0	00,7	05 9	00,8	05 9	00,9	05 9	00,9	6
7	07 0	00 7	07 0	00 7	06.9	00,9	06,9	01 0	06,9	01 0	06,9	01 1	7
8	08 0	00 8	08 0	00 8	07 9	01,0	07 9	01 1	07 9	01 2	07 9	01 3	8
9	09 0	00 9	08 9	00 9	08 9	01,1	08 9	01 2	08 9	01 3	08 9	01,4	9
10	10 0	01,0	09 9	01 0	09 9	01,2	09 9	01 4	09 9	01 5	09 9	01 6	10
11	10,9	01 1	10 9	01,1	10 9	01,3	10 9	01,5	10 9	01,6	10 9	01 7	11
12	11 9	01 2	11,9	01 3	11,9	01,5	11,9	01 7	11,9	01,8	11,9	01 9	12
13	12 9	01 3	12 9	01 4	12 9	01,6	12 9	01 8	12 9	01,9	12 9	02 0	13
14	13 9	01 4	13 9	01 5	13 9	01,7	13 9	01 9	13 8	02,1	13 8	02 2	14
15	14 9	01,5	14 9	01 6	14 9	01 8	14 9	02 1	14 8	02,2	14 8	02,3	15
16	15 9	01 6	15 9	01,7	15 9	01,9	15 8	02,2	15 8	02,3	15,8	02 5	16
17	16,9	01 7	16,9	01 8	16,9	02 1	16,8	02 4	16,8	02,5	16 8	02,7	17
18	17 9	01 8	17 9	01 9	17 9	02 2	17 8	02 5	17 8	02,6	17 8	02 8	18
19	18 9	01 9	18 9	02 0	18 9	02 3	18 8	02 6	18 8	02,8	18 8	03 0	19
20	19 9	02 0	19 9	02 1	19 8	02 4	19 8	02 8	19 8	02,9	19 8	03 1	20
21	20 9	02,1	20 9	02,2	20 8	02,6	20 8	02,9	20,8	03,1	20,7	03 3	21
22	21,9	02 2	21,9	02 3	21,8	02 7	21,8	03 1	21 8	03,2	21 7	03 4	22
23	22 9	02 3	22 9	02 4	22,8	02 8	22 8	03 2	22 8	03,4	22 7	03 6	23
24	23 9	02 4	23 9	02 5	23,8	02 9	23 8	03 3	23 7	03,5	23 7	03,8	24
25	24 9	02 4	24 9	02 6	24,8	03 0	24 8	03 5	24 7	03,7	24 7	03 9	25
26	25 9	02,5	25 9	02,7	25,8	03,2	25 7	03,6	25,7	03,8	25,7	04 1	26
27	26,9	02,6	26,9	02 8	26,8	03 3	26,7	03 8	26 7	04 0	26 7	04 2	27
28	27 9	02,7	27 8	02 9	27,8	03 4	27 7	03 9	27 7	04 1	27 7	04,4	28
29	28 9	02,8	28 8	03 0	28,8	03 5	28 7	04 0	28 7	04 3	28 6	04 5	29
30	29 9	02,9	29 8	03 1	29,8	03 7	29 7	04 2	29 7	04 4	29 6	04 7	30
31	30 8	03,0	30 8	03,2	30,7	03,8	30 7	04,3	30,7	04,5	30,6	04,9	31
32	31,8	03,1	31,8	03 3	31,7	03 9	31,7	04 5	31 7	04 7	31 6	05 1	32
33	32 8	03,2	32 8	03 4	32.7	04 0	32 7	04 6	32 6	04 8	32 6	05 2	33
34	33 8	03,3	33 8	03 6	33,7	04 1	33 7	04 7	33 6	05 0	33 6	05 4	34
35	34 8	03,4	34 8	03 7	34,7	04 3	34 7	04 9	34 6	05 1	34 6	05 5	35
36	35 8	03,5	35 8	03,8	35,7	04,4	35,6	05,0	35.6	05,3	35,6	05,6	36
37	36,8	03 6	36,8	03 9	36,7	04 5	36 6	05 1	36 6	05 4	36 5	05,8	37
38	37 8	03 7	37 8	04 0	37,7	04 6	37 6	05 3	37 6	05 6	37 5	05,9	38
39	38 8	03 8	38 8	04 1	38,7	04 8	38 6	05 4	38 6	05 7	38 5	06 1	39
40	39 8	03 9	39 8	04 2	39,7	04 9	39 6	05 6	39 6	05 9	39 5	06 3	40
Diff.	dep.	Lat.	dep,	Lat.	dep.	Lat.	dep.	Lat.	dep	Lat,	dep,	Lat	Diff.
	7. 19. Pt.		84 Deg.		83 Deg.		82 Deg		17, 19 Pt,		81 Deg.		

Dist.	half Pt.		6 Deg.		7 Deg.		8 deg.		3 q. Pt.		9 Deg.		Dist.
	Lat.	dep	Lat.	dep	Lat.	dep	Lat.	dep.	Lat.	dep.	Lat.	dep.	
41	40,8	4.0	40,8	4,3	40 7	0 ,0	40,6	05.7	40,6	06,0	40.5	06.4	41
42	41 6	4 1	41 8	4 4	41 7	05 1	41 6	05 8	41 5	06 2	41 5	066	42
43	42 8	4 2	42 8	4 5	42 7	05 2	42 6	06 0	42 5	06 3	42 5	067	43
44	43 8	4 3	43 7	4 6	43 7	05 4	43 6	06 1	43 5	06 5	43 5	069	44
45	44 8	4 4	44 7	4 7	44 7	05 5	44 6	06 3	44 5	066	44 5	07 0	45
46	45 8	4 5	45 7	4 8	45 7	05 6	45 6	06 4	45 5	067	45 4	07 2	46
47	46 8	4 6	46 7	4 9	46 6	05 8	46 5	06 5	46 5	069	46 4	07 3	47
48	47 8	4 7	47 7	5 0	47 6	05 9	47 5	06 7	47 5	07 0	47 4	07 5	48
49	48 8	4 8	48 7	5 1	48 6	06 0	48 5	06 8	48 5	07 2	48 4	07 7	49
50	49 8	4 9	49 7	5 2	49 6	06 1	49 5	07 0	49 5	07 3	49 4	07 8	50
51	50,7	5,0	50.7	5 3	50,6	06,2	50,5	07.1	50,4	07,5	50,4	08.0	51
52	51 7	5 1	51 7	5 4	51 6	06 3	51 5	07 2	51 4	07 6	51 4	08 1	52
53	52 7	5 2	52 7	5 6	52 6	06 5	52 5	07 4	52 4	07 8	52 4	08 3	53
54	53 7	5 3	53 7	5 7	53 6	06 6	53 5	07 5	53 4	07 9	53 3	08 4	54
55	54 7	5 4	54 7	5 7	54 6	06 7	54 5	07 6	54 4	08 1	54 3	086	55
56	55 7	5 5	55 7	5 8	55 6	06 8	55 5	07 8	55 4	08 2	55 3	087	56
57	56 7	5 6	56 7	6 0	56 6	06 9	56 4	07 9	56 4	08 4	56 3	089	57
58	57 7	5 7	57 7	6 1	57 6	07 1	57 4	08 1	57 4	08 5	57 3	09 1	58
59	58 7	5 8	58 7	6 2	58 6	07 2	58 4	08 2	58 4	08 7	58 3	09 2	59
60	59 7	5 9	59 7	6 3	59 6	07 3	59 4	08 3	59 4	08 8	59 3	09 4	60
61	60,7	6,0	60.6	6,4	60.5	07,4	60.4	08,5	60,3	08,9	60,2	09,5	61
62	61 7	6 1	61 6	6 5	61 5	07 6	61 4	08 6	61 3	09 1	61 2	09 7	62
63	62 7	6 2	62 6	6 6	62 5	07 7	62 4	08 7	62 3	09 2	62 2	09 9	63
64	63 7	6 3	63 6	6 7	63 5	07 8	63 4	08 8	63 3	09 4	63 2	100	64
65	64 7	6 4	64 6	6 8	64 5	07 9	64 4	09 1	64 3	09 5	64 2	102	65
66	65 7	6 5	65 6	6 9	65 5	08 0	65 4	09 2	65 3	09 7	65 2	103	66
67	66 7	6 6	66 6	7 0	66 5	08 2	66 3	09 3	66 3	09 8	66 2	105	67
68	67 7	6 7	67 6	7 1	67 5	08 3	67 3	09 5	67 3	100	67 1	106	68
69	68 7	6 8	68 6	7 2	68 5	08 4	68 3	09 6	68 2	10 2	68 1	108	69
70	69 7	6 9	69 6	7 3	69 5	08 5	69 3	09 7	69 2	10 3	69 1	109	70
71	70,6	7,0	70,6	7,4	70,5	08,7	70,3	09,9	70,2	10,4	70,1	11.1	71
72	71 6	7 1	71 6	7 5	71 5	08 8	71 3	10 0	71 2	10 6	71 1	11 2	72
73	72 6	7 1	72 6	7 6	72 4	08 9	72 3	10 2	72 2	10 7	72 1	11 4	73
74	73 6	7 2	73 6	7 7	73 4	09 0	73 3	10 3	73 2	10 9	73 1	11 6	74
75	74 6	7 3	74 6	7 8	74 4	09 1	74 3	10 4	74 2	11 0	74 1	11 7	75
76	75 6	7 4	75 6	7 9	75 4	09 3	75 3	10 6	75 2	11 1	75 1	11 9	76
77	76 6	7 5	76 6	8 0	76 4	09 4	76 2	10 7	76 2	11 3	76 0	12 0	77
78	77 6	7 6	77 6	8 1	77 4	09 5	77 2	10 9	77 1	11 4	77 0	12 2	78
79	78 6	7 7	78 6	8 3	78 4	09 6	78 2	11 0	78 1	11 6	78 0	12 4	79
80	79 6	7 8	79 6	8 4	79 4	09 8	79 2	11 1	79 1	11 7	79 0	12 5	80
Dist.	dep	L.	dep	L,	dep.	Lat.	dep,	Lat,	dep,	Lat,	dep.	Lat	Dist.
	7 P, 1 h,		84 Deg,		83 deg.		82 deg,		7. P. 1q,		84 Deg,		

Dif.	half Pnt,		6 deg.		7 Deg.		8 Deg,		3 q, Pt,		9 Deg,		Dif.
	Lat,	dep,	Lat,	dep	Lat	dep,	Lat,	dep	Lat,	dep,	Lat	dep,	
81	80.6	7.9	80.5	8,5	80,9	9,9	80,2	11.3	80,1	11.9	80,0	12,7	81
82	81 6	8 0	81 5	8 6	81 4	.00	81 2	11 4	81 1	120	81 0	12 8	82
83	82 6	8 1	82 5	8 7	82 4	101	82 2	11 4	82 1	122	82 0	13 0	83
84	83 6	8 2	83 5	8 8	83 4	10 2	83 2	11 7	83 1	123	83 0	13 1	84
85	84 6	8 3	84 5	8 9	84 4	10 3	84 2	11 8	84 1	125	83 9	13 3	85
86	85 6	8 4	85 5	9 0	85 4	10 4	85 2	12 0	85 1	126	84 9	13 4	86
87	86 6	8 5	86 5	9 1	86 3	10 5	86 1	12 1	86 0	128	85 9	13 6	87
88	87 6	8 6	87 5	9 2	87 3	10 7	87 1	12 2	87 0	129	86 9	13 8	88
89	88 6	8 7	88 5	9 3	88 3	10 9	88 1	12 4	88 0	131	87 9	13 9	89
90	89 6	8 8	89 5	9 4	80 2	11 0	89 1	12 5	89 0	13 2	88 0	14 1	90
91	90,6	8,9	80.5	9,5	90,3	11,1	90.1	12.7	90.0	13.4	89,9	14.2	91
92	91 6	9 0	91 5	9 6	91 3	11 2	91 1	12 8	91 0	13 5	90 9	14 4	92
93	92 6	9 1	92 5	9 7	92 3	11 3	92 1	12 9	92 0	13 6	91 8	14 5	93
94	93 6	9 2	93 5	9 8	93 3	11 5	93 1	13 1	93 0	13 8	92 8	14 7	94
95	94 5	9 3	94 5	9 9	94 3	11 6	94 1	13 2	94 0	13 9	93 8	14 9	95
96	95 5	9 4	95 5	100	95 3	11 7	95 1	13 4	95 0	14 1	94 8	15 0	96
97	96 5	9 5	96 5	10 1	96 3	11 8	96 0	13 5	95 9	14 2	95 8	15 2	97
9	97 5	9 6	97 5	10 2	97 3	12 0	97 0	13 6	96 9	14 4	96 8	15 3	98
99	98 5	9 7	98 5	10 3	98 3	21	98 0	13 8	97 9	14 5	97 8	15 5	99
100	99,5	9 8	99 5	10 4	99 2	12 2	99 0	13 9	98 9	14 7	98 8	15 8	100
101	00 5	10,9	100,4	09 6	100.2	12.3	100,0	14.1	99.9	14,8	99,8	15.8	101
102	1 5	10 0	1 4	10 7	1 2	12 4	1 0	14 2	100 9	15 0	100 7	16 0	102
103	2 5	10	2 4	10 8	2 2	12 5	2 0	14 3	1 9	15 1	1 7	16 1	103
104	3 5	10 2	3 4	10 9	3 2	12 7	3 0	14 5	2 9	15 3	2 7	16 3	104
105	4 5	10 3	4 4	11 0	4 2	12 8	4 0	14 6	3 9	15 4	3 7	16 4	105
106	5 5	10 4	5 4	11 1	5 2	12 9	5 0	14 8	4 9	15 5	4 7	16 6	106
107	6 5	10 5	6 4	11 2	6 2	13 0	6 0	14 9	4 9	15 7	5 7	16 7	107
108	7 5	10 6	7 4	11 3	7 2	13 1	7 0	15 0	5 9	15 9	6 7	16 9	108
109	8 5	10 7	8 4	11 4	8 2	13 3	7 9	15 2	6 9	16 0	7 7	17 0	109
110	109 5	10 8	109 4	11 5	109 2	13 4	108 9	15 3	107 9	16 1	1086	17 2	110
111	110,5	10.9	110,4	11.6	110.2	13,5	109.9	15,5	8.9	16.3	99.6	17.4	111
112	1 5	11 0	1 4	11 7	1 2	13 6	110 9	15 6	98	16 4	100 6	17 5	112
113	2 5	11 1	2 4	11 8	2 2	13 8	1 9	15 7	1108	16 6	101 6	17 7	113
114	3 5	11 2	3 4	11 9	3 1	13 9	2 9	15 9	1 8	16 7	2 6	17 9	114
115	4 4	11 3	4 4	12 0	4 1	14 0	3 9	16 0	2 8	16 9	3 6	18 0	115
116	5 4	11 3	5 4	12 1	5 1	14 1	4 9	16 1	3 7	17 0	4 6	18 1	116
117	6 4	11 4	6 4	12 2	6 1	14 2	5 9	16 3	4 7	17 2	5 6	18 3	117
118	7 4	11 5	7 4	12 3	7 1	14 4	6 9	16 4	5 7	17 3	6 5	18 5	118
119	8 4	11 6	8 3	12 4	8 1	14 5	7 8	16 6	6 7	17 5	7 5	18 6	119
120	1194	11 7	120 2	12 5	1191	14 6	1188	16 7	1177	17 6	1185	18 8	120
Dif.	dep,	Lat	dep.	Lat.	dep,	Lat,	dep.	Lat,	dep.	Lat.	dep,	Lat,	Dif.
	7 P, 1 h,		84 deg.		83 Deg.		82 Deg,		3q, of a Pt.		81 Deg.		

Dist.	19 Pnt,		0 deg,		7 deg.		8 Deg,		9 Pnt.		9 Deg,		Dist.
	Lat.	dep.	Lat,	dep,	Lat,	dep.	Lat.	dep.	Lat,	dep,	Lat,	dep,	
121	120,4	11,8	120.3	12,6	120,1	14,7	119.8	16,8	118.7	17,7	119.5	8.9	121
122	1 4	11 9	1 3	12 7	1 1	14 9	120 8	17 0	9 7	17 9	120 5	19 1	122
123	2 4	12 0	2 3	12 8	2 1	15 0	1 8	17 1	120 7	18 1	1 5	19 2	123
124	3 4	12 1	3 3	13 0	3 1	15 1	2 8	17 3	1 7	18 2	2 5	19 4	124
125	4 4	12 2	4 3	13 1	4 1	15 3	3 8	17 4	2 7	18 3	3 5	19 6	125
126	5 4	12	5 3	13 2	5 1	15 3	4 8	17 5	3 7	18 5	4 5	19 7	126
127	6 4	12	6 3	13 3	6 0	15 5	5 8	17 7	4 6	18 6	5 4	19 9	127
128	7 4	12 4	7 3	13 4	7 0	15 6	6 8	17 8	5 6	18 8	6 4	20 0	128
129	8 4	12 5	8 3	13 5	8 0	15 7	7 7	18 0	6 6	18 9	7 4	20	129
130	129 4	12 6	129 3	13 6	129 0	15 8	8 7	18 1	127 6	19 1	8 4	20 3	130
131	130,4	12,8	130,3	13.7	130.0	16.0	129.7	18,2	128,6	19,2	129,4	20,5	131
132	1 4	12 9	1 3	13 8	1 0	16 1	130 7	18 4	9 6	19 3	130 4	20 6	132
133	2 4	13 0	2 3	13 9	2 0	16 2	1 7	18 5	130 6	19 5	1 4	20 8	133
134	3 4	13 1	3 4	14 0	3 0	16 3	2 7	18 7	1 6	19 6	2 4	21 0	134
135	4 4	13 2	4 6	14 1	4 0	16 4	3 7	18 8	2 6	19 8	3 3	21 1	135
136	5 3	13 3	5 5	14 2	5 0	16 6	4 7	18 9	3 5	19 9	4 3	21 3	136
137	6 3	13 4	6 2	14 3	6 0	16 7	5 7	19 1	4 5	20 1	5 3	21 4	137
138	7 3	13 5	7 2	14 4	7 0	16 8	6 7	19 2	5 5	20 2	6 3	21 6	138
139	8 3	13 6	8 2	14 5	8 0	16 9	7 7	19 4	6 5	20 4	7 3	21 7	139
140	139 3	13 7	139 2	14 6	139 0	17 1	8 6	19 5	137 5	20 5	8 2	21 9	140
141	140,3	13,8	140.2	14,7	139,9	17.2	139 6	19.6	138,5	20,7	139.3	22,1	141
142	1 3	13 9	1 2	14 8	140 9	17 3	140 6	19 8	9 5	20 8	140 3	22 2	142
143	2 3	14 0	2 2	14 9	1 9	17 4	1 6	19 9	140 5	21 0	1 2	22 4	143
144	3 3	14 1	3 2	14 0	2 9	17 5	2 6	20 0	1 4	21 1	2 2	22 5	144
145	4 3	14 2	4 2	15 2	3 9	17 7	3 6	20 2	2 4	21 3	3 2	22 7	145
146	5 3	14 3	5 2	15 3	4 9	17 8	4 6	20 3	3 4	21 4	4 2	22 8	146
147	6 3	14 4	6 2	15 4	5 9	17 9	5 6	20 5	4 4	21 6	5 2	23 0	147
148	7 3	14 5	7 2	15 5	6 9	18 0	6 6	20 6	5 4	21 7	6 2	23 1	148
149	8 3	14 6	8 2	15 6	7 9	18 1	7 5	20 7	6 4	21 8	7 2	23 3	149
150	149 3	14 7	149 2	15 7	8 9	18 2	8 5	20 9	147 4	22 0	8 2	23 0	150
151	150,3	14,8	150,2	15,8	149,9	18.4	149.5	21.0	8,4	22,1	149,1	23,6	151
152	1 3	14 9	1 2	15 9	150 9	18 5	150 5	21 2	9 4	22 3	150 1	23 8	152
153	2 3	15 0	2 2	16 0	1 9	18 6	1 5	21 3	150 3	22 4	1 1	23 9	153
154	3 3	15 1	3 2	16 1	2 8	18 7	2 5	21 4	1 3	22 6	2 1	24 1	154
155	4 3	15 2	4 2	16 2	3 8	18 9	3 5	21 6	2 3	22 7	3 1	24 2	155
156	5 3	15 3	5 1	16 3	4 8	19 0	4 5	21 7	3 3	22 6	4 1	24 4	156
157	6 2	15 4	6 1	16 4	5 8	19 1	5 5	21 9	4 3	23 0	5 1	24 6	157
158	7 2	15 5	7 1	16 5	6 8	19 2	6 5	22 0	5 3	23 2	6 1	24 7	158
159	8 2	15 6	8 1	16 6	7 8	19 4	7 5	22 1	6 3	23 3	7 0	24 9	159
160	159 2	15 7	159 1	16 7	158 8	19 5	8 4	22 3	157 3	23 3	158 0	25 0	160
Dist.	dep,	Lat,	dep.	Lat,	dep,	Lat,	dep.	Lat	dep,	Lat.	dep,	Lat,	Dist.
	8 Pt, half		84 deg,		83 Deg.		82 Deg,		7 Pt. 19.		81 Deg.		

Dist.	10 Deg.		11 Deg.		1 Point.		12 Deg.		13 Deg.		14 Deg.		Dist.
	Lat.	deg.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
1	01,0	00,2	01,0	00,2	01,0	00,2	01,0	00,2	01,0	00,2	01,0	00,2	1
2	02 0	00 3	02 0	00 4	02 0	00,4	02 0	00 4	01 9	00 4	01 9	00 5	2
3	03 9	00 6	03 9	00 6	03 9	00,6	03 9	00 6	02 9	00 7	02 9	00 7	3
4	04 9	00 7	04 9	00 8	04 9	00 8	04 9	00 8	02 9	00 9	03 9	01 0	4
5	05 9	00 9	05 9	00 9	05 9	01 0	05 9	01 0	03 9	01 1	04 8	01 2	5
6	06,9	01,0	06,9	01,1	06,9	01 2	05 9	01,2	04,8	01,3	05 8	01,4	6
7	07 9	01 2	07 9	01 3	06 9	01,4	06,8	01 5	06,8	01 6	06,8	01 7	7
8	08 9	01 4	08 8	01 5	07 8	01 6	07 8	01 7	07 8	01 8	07 8	01 9	8
9	09 9	01 6	08 8	01 7	08 8	01,8	08 8	01 9	08 8	02 0	08 7	02 2	9
10	10 8	01 7	09 8	01 9	09 8	01,9	09 8	02 1	09 7	02 2	09 7	02 4	10
11	10,8	01,9	10 8	02,1	10 8	02,1	10 8	02,3	10 7	02,5	10 7	02.7	11
12	11 8	02 1	11,8	02 3	11,7	02 3	11,7	02 5	11,7	02 7	11,6	02 9	12
13	12 8	02 3	12 8	02 5	12 7	02 5	12 7	02 7	12 7	02 9	12 6	03 1	13
14	13 8	02 4	13 7	02 7	13 7	02 7	13 7	02 9	13 6	03 1	13 6	03 4	14
15	14 8	02 6	14 7	02 9	14 7	02,9	14 7	03 1	14 6	03 4	14 5	03 6	15
16	15 7	02,8	15 7	03 1	15 6	03,1	15 6	03,3	15 6	03 6	15,5	03,9	16
17	16,7	02 9	16,7	03,3	16,6	03,3	16.6	03 5	16,6	03,8	16 5	04,1	17
18	17 7	03 1	17 7	03 5	17 6	03 5	17 6	03 7	17 5	04 0	17 5	04,4	18
19	18 7	03 3	18 6	03 7	18 6	03 7	18 6	03 9	18 5	04 2	18 4	04 6	19
20	19 7	03 5	19 6	03 9	19 6	03 9	19 6	04 2	19 5	04 5	19 4	04 8	20
21	20 7	03,6	20 6	04,0	20 6	04,1	20 5	04,4	20,5	04,7	20,4	05,1	21
22	21,7	03 8	21,6	04,2	21,6	04 3	21,5	04 6	21 4	04,9	21 3	05 3	22
23	22 6	04,0	22 6	04 4	22,6	04 5	22 5	04 8	22 4	05,2	22 3	05 6	23
24	23 6	04,2	23 6	04 6	23,5	04 7	23 5	05 0	23 4	05 4	23 3	05 8	24
25	24 6	04,3	24 5	04 8	24,5	04 9	24 4	05 2	24 3	05 6	24 3	06,0	25
26	25 6	04 5	25 5	05,0	25,5	05 1	25 4	05,4	25,3	05 8	25,2	06 3	26
27	26,6	04 7	26,5	05,1	26,5	05,3	26,4	05 6	26 3	06 1	26 2	06 5	27
28	27 6	04 9	27 5	05 3	27,5	05 5	27 4	05 8	27 3	06,3	27 2	06 8	28
29	28 6	05 0	28 5	05 5	28,5	05 7	28 4	06 0	28 2	06,5	28 1	07 0	29
30	29 6	05,2	29 4	05 7	29,5	05,8	29 3	06 2	29 2	06,7	29 1	07 3	30
31	30 5	05,4	30 4	05,9	30,4	06,0	30 3	06,4	30,2	07,0	30,1	07,5	31
32	31,5	05,5	31,4	06 1	31,4	06 2	31,3	06 6	31 2	07,2	31 0	07 7	32
33	32 5	05,7	32 4	06,3	32.4	06 4	32 3	06 9	32 1	07.4	32 0	08 0	33
34	33 5	05,9	33 4	06 5	33,3	06 6	33 2	07 1	33 1	07,6	33 0	08 2	34
35	34 5	06 1	34 4	06 7	34,3	06,8	34 2	07 3	34 1	07.9	34 0	08,5	35
36	35 4	06 2	35 3	06,9	35,3	07,0	35,2	07.5	35.1	08,1	35,9	08 7	36
37	36,4	06 4	36 3	07 1	36,3	07,2	36 2	07 7	36 0	08,3	36 9	09 0	37
38	37 4	06,6	37 3	07 2	37,3	07,4	37 2	07 9	37 0	08,5	37 9	09 2	38
39	38 4	06,8	38 3	07 4	38,2	07 6	38 1	08 1	38 0	08,8	38 8	09,4	39
40	39 4	06,9	39 3	07,6	39,2	07,8	39 3	08 1	39 0	09,0	39 8	09 7	40
Dist.	dep	Lat.	dep,	Lat.	dep,	Lat	dep	Lat.	dep,	Lat,	dep.	Lat.	Dist.
	80 Deg,		78 Deg.		7 Points,		76 Deg.		77 Deg		76 Deg.		

Dist.	10 Deg.		11 Deg.		1 Point		12 deg.		13 Deg.		14 Deg.		Dist.
	Lat.	dep.	Lat.	dep.	Lat.	dep	Lat.	dep.	Lat.	dep.	Lat.	dep.	
41	40,4	7,1	40,2	7,8	40.2	8,0	40,1	8.5	41,4	9,2	39.8	9.9	41
42	41 4	7 3	41 2	8 0	41 2	8 2	41 1	8 7	40 9	9 4	40 7	10 2	42
43	42 3	7 5	42 2	8 2	42 2	8 4	42 1	9 1	41 9	9 7	41 7	10 4	43
44	43 3	7 7	43 2	8 4	43 1	8 6	43 0	9 9	42 9	9 9	42 7	10 6	44
45	44 3	7 8	44 2	8 6	44 1	8 8	44 0	9 4	43 8	10 1	43 7	11 0	45
46	45 3	7 0	45 2	8 8	45 1	9 0	45 0	9 6	44 7	10 3	44 6	11 1	46
47	46 3	8 2	46 1	9 0	46 1	9 2	46 0	9 8	45 8	10 6	45 6	11 9	47
48	47 3	8 3	47 1	9 2	47 1	9 4	47 0	10 0	46 7	10 8	46 6	11 6	48
49	48 3	8 5	48 1	9 3	48 1	9 6	47 9	10 2	47 7	11 0	47 5	11 9	49
50	49 3	8 7	49 1	9 5	49 0	9 8	48 9	10 4	48 7	11 2	48 5	12 1	50
51	50,2	8,8	50.1	9,7	50,0	10,0	49,9	10.6	49,7	11,5	49,5	12.3	51
52	51 2	9 0	51 0	9 9	51 0	10 1	50 9	10 8	50 7	11 7	50 5	12 6	52
53	52 2	9 2	52 0	10 1	52 0	10 3	51 8	11 0	51 6	11 9	51 4	12 8	53
54	53 2	9 4	53 0	10 3	53 0	10 5	52 8	11 2	52 6	12 1	52 4	13 1	54
55	54 2	9 5	54 0	10 5	53 9	10 7	53 8	11 4	53 6	12 4	53 4	13 3	55
56	55 1	9 7	55 0	10 8	54 9	10 9	54 8	11 6	54 5	12 6	54 3	13 5	56
57	56 1	9 9	56 0	10 0	55 9	11 1	55 8	11 8	55 5	12 8	55 3	13 8	57
58	57 1	10 1	57 0	11 1	56 9	11 3	56 7	12 1	56 5	13 0	56 3	14 0	58
59	58 1	10 2	57 9	11 3	57 9	11 5	57 7	12 3	57 5	13 3	57 2	14 3	59
60	59 1	10 4	58 9	11 4	58 8	11 7	58 7	12 5	58 5	13 5	58 2	14 5	60
61	60,1	10,6	59.9	11 6	59.8	11,9	59.7	12,7	59,4	13,7	59,2	14,8	61
62	61 1	10 8	60 9	11 8	60 8	12 1	60 6	12 9	60 4	13 9	60 2	15 0	62
63	62 0	10 9	61 8	12 0	61 8	12 3	61 6	13 1	61 4	14 2	61 1	15 2	63
64	63 0	11 1	62 8	12 2	62 8	12 5	62 6	13 3	62 3	14 4	62 1	15 4	64
65	64 0	11 3	63 8	12 4	63 7	12 7	63 6	13 5	63 3	14 6	63 1	15 6	65
66	65 0	11 5	64 8	12 6	64 7	12 9	64 6	13 7	64 3	14 8	64 0	16 0	66
67	66 0	11 6	65 8	12 8	65 7	13 1	65 5	13 9	65 3	15 1	65 0	16 2	67
68	67 0	11 8	66 7	13 0	66 7	13 3	66 5	14 1	66 2	15 3	66 0	16 4	68
69	68 0	12 0	67 7	13 2	67 7	13 5	67 5	14 3	67 2	15 5	66 9	16 7	69
70	68 9	12 2	68 7	13 4	68 7	13 7	68 5	14 5	68 2	15 7	67 0	16 9	70
71	69.9	12.3	69,7	13,5	69,6	13,9	69,4	14,8	69,2	16,0	68,9	17.2	71
72	70 9	12 5	70 7	13 7	70 6	14 0	70 4	15 0	70 1	16 2	69 9	17 4	72
73	71 9	12 7	71 7	13 9	71 6	14 2	71 4	15 2	71 1	16 4	70 8	17 6	73
74	72 9	12 9	72 6	14 1	72 6	14 4	72 4	15 4	72 1	16 6	71 8	17 9	74
75	73 9	13 0	73 6	14 3	73 6	14 6	73 4	15 6	73 1	16 9	72 8	18 1	75
76	74 8	13 2	74 6	14 5	74 5	14 8	74 3	15 8	74 0	17 1	63 7	18 4	76
77	75 8	13 4	75 6	14 7	75 5	15 0	75 3	16 0	75 0	17 3	74 7	18 6	77
78	76 8	13 5	76 6	14 9	76 5	15 2	76 3	16 2	76 0	17 5	75 7	18 9	78
79	77 8	13 7	77 6	15 1	77 5	15 4	77 3	16 4	77 0	17 8	76 6	19 2	79
80	78 8	13 9	78 6	15 3	78 5	15 6	78 2	16 6	77 9	18 0	77 6	19 2	80
Dist.	dep	Lat.	dep	Lat,	dep.	Lat.	dep,	Lat,	dep,	Lat,	dep.	Lat.	Dist.
	80 Deg.		11 Deg,		1 Point,		78 deg,		77 deg.		70 Deg,		

	10 Deg.		11 Deg.		1 Point,		12 Deg.		13 Deg.		14 deg.		
	Lat.	Lat.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
81	79.8	14.1	79	15.5	79.4	15.8	79.2	16.8	78.9	18.2	78.6	19.4	81
82	80 8	14 2	80 5	15 6	80 4	16 0	80 2	17 0	79 9	18 4	79 6	19 8	82
83	81 7	14 4	81 5	15 8	81 4	16 2	81 2	17 2	80 9	18 7	80 6	20 1	83
84	82 7	14 6	82 5	16 0	82 4	16 4	82 2	17 3	81 8	18 9	81 5	20 3	84
85	83 7	14 8	83 4	16 2	83 4	16 6	83 1	17 7	82 8	19 1	82 5	20 6	85
86	84 7	14 9	84 4	16 4	84 3	16 8	84 1	17 9	83 8	19 3	83 4	20 8	86
87	85 7	15 1	85 4	16 6	85 3	17 2	85 1	18 1	84 8	19 6	84 4	21 0	87
88	86 7	15 3	86 4	16 8	86 3	17 3	86 1	18 3	85 7	19 8	85 4	21 3	88
89	87 6	15 4	87 4	17 0	87 3	17 4	87 1	18 5	86 7	20 0	86 4	21 5	89
90	88 6	15 6	88 3	17 2	88 3	17 6	88 0	18 7	87 7	20 2	87 4	21 8	90
91	89,6	15,8	89.3	17,4	99,2	17,8	89 0	18.9	88.7	20.5	88,3	22.2	91
92	90 6	16 0	80 3	17 6	90 2	17 9	90 0	19 1	89 6	20 7	89 3	22 5	92
93	91 6	16 1	91 3	17 7	91 2	18 1	91 0	19 2	90 6	20 9	90 2	22 7	93
94	92 6	16 3	92 3	17 9	92 2	18 3	92 0	19 4	91 6	21 1	91 2	22 9	94
95	93 5	16 5	93 3	18 1	93 2	18 5	92 9	19 6	92 6	21 3	92 2	23 0	95
96	94 5	16 7	94 2	18 3	94 2	18 7	93 9	20 0	93 5	21 6	93 1	23 2	96
97	95 5	16 8	95 2	18 5	95 1	18 9	94 9	20 2	94 5	21 8	94 1	23 5	97
98	96 5	17 0	96 2	18 7	96 1	19 1	95 9	20 4	95 5	32 0	95 1	23 7	98
99	97 5	17 2	97 2	18 9	97 1	19 3	96 8	20 6	96 5	22 3	96 0	23 9	99
100	98 5	17 4	98 2	19 1	98 1	19 8	97 8	20 8	97 4	22 5	97 0	24 0	100
101	99.5	17,5	99.1	19.3	99.1	19.7	8,8	21.0	98.7	22,7	98,0	24.4	101
102	100 4	17 7	100 1	19 5	100 0	19 9	9 8	21 2	99 4	22 9	99 0	24 7	102
103	1 4	17 9	1 1	19 7	1 0	20 1	100 7	21 4	100 3	23 2	99 9	24 9	103
104	2 4	18 0	2 1	19 8	2 0	20 3	1 7	21 6	1 3	23 4	100 9	25 2	104
105	3 4	18 2	3 1	20 0	3 0	20 4	2 7	21 8	2 3	23 6	1 9	25 4	105
106	4 4	18 4	4 0	20 2	4 0	20 7	3 7	22 0	3 3	23 8	2 8	25 7	106
107	5 4	18 6	5 0	20 4	4 9	20 9	4 6	22 3	4 2	24 1	3 8	25 9	107
108	6 4	18 7	6 0	20 6	5 9	21 1	5 6	22 4	5 2	24 3	4 8	26 1	108
109	7 3	18 9	7 0	20 8	6 9	21 3	6 6	22 7	6 2	24 5	5 8	26 4	109
110	108 3	19 1	108 0	21 0	107 9	21 4	107 6	22 9	107 2	24 7	6 7	26 6	110
111	9,3	19.3	9,0	21.2	8.9	21,7	8.6	23,1	8.2	25.0	7.7	26.9	111
112	110 3	19 4	9 9	21 4	9 8	21 9	9 5	23 3	9 1	25 2	8 7	27 1	112
113	1 3	19 6	110 9	21 6	110 8	22 0	110 5	23 5	110 1	25 4	9 6	27 3	113
114	2 3	19 8	1 9	21 8	1 8	22 3	1 5	23 7	1 1	25 6	110 6	27 6	114
115	3 3	19 9	2 9	21 9	2 8	22 5	2 5	23 9	2 1	25 9	1 6	27 8	115
116	4 2	20 1	3 9	22 1	3 8	22 6	3 4	24 1	3 0	26 1	2 6	28 1	116
117	5 2	20 3	4 8	22 3	4 7	22 8	4 4	24 3	4 0	26 3	3 6	28 3	117
118	6 2	20 5	5 8	22 5	5 7	23 0	5 4	24 5	5 0	26 5	4 5	28 6	118
119	7 2	20 6	6 8	22 7	6 7	23 3	6 4	24 8	6 0	26 8	5 5	28 8	119
120	118 2	20 8	117 8	22 9	117 7	23 5	117 4	25 0	117 9	27 0	116 4	29 0	120
	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	
	80 deg.		79 Deg.		7 Points		78 Deg.		77 deg.		76 Deg.		

Dist.	10 Deg.		11 deg.		1 Point		12 Deg.		13 Deg.		14 Deg.		Dist.
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
121	119.2	21.0	118.8	23.1	118.7	23.6	118.3	25.2	117.8	27.3	117.4	29.3	121
122	120 1	21 2	9 8	23 3	119 0	23 6	9 3	25 4	8 9	27 4	8 4	29 5	122
123	1 1	21 3	120 7	23 5	120 6	24 0	120 3	25 6	9 8	27 7	9 3	29 8	123
124	2 1	21 5	1 7	23 7	1 6	24 3	1 3	25 8	120 8	27 9	20 3	30 0	124
125	3 1	21 7	2 7	23 9	2 6	24 5	2 3	26 0	1 8	28 1	1 3	30 2	125
126	4 1	21 8	3 7	24 0	3 6	24 8	3 2	26 2	2 8	28 3	2 3	30 5	126
127	5 1	22 0	4 7	24 2	4 6	24 8	4 2	26 4	3 7	28 6	3 2	31 7	127
128	6 1	22 2	5 6	24 4	5 6	25 0	5 2	26 6	4 7	28 8	4 2	31 0	128
129	7 0	22 4	6 6	24 6	6 5	25 2	6 2	26 8	5 7	29 0	5 2	31 2	129
130	128 0	22 5	127 6	24 8	127 5	25 4	7 1	27 0	126 7	29 2	6 1	31 5	130
131	9,0	22,7	8,6	25.0	8,5	25 6	8.1	27,2	127,5	29,5	7,1	31,7	131
132	130 0	22 9	9 6	25 2	9 5	25 8	9 1	27 5	8 6	29 7	8 1	31 9	132
133	1 0	23 1	130 5	23 4	130 4	26 0	130 1	27 7	9 6	29 9	9 0	32 2	133
134	2 0	23 2	1 5	25 6	1 4	26 1	1 1	27 9	130 6	30 0	130 0	32 4	134
135	3 9	23 4	2 5	25 8	2 4	26 3	2 0	28 1	1 6	30 4	1 0	32 7	135
136	4 9	23 6	3 5	25 0	3 4	26 5	3 0	28 3	2 5	30 6	2 0	32 9	136
137	5 9	23 8	4 5	26 2	4 4	26 7	4 0	28 5	3 5	30 8	2 9	33 8	137
138	6 9	23 9	5 5	26 4	5 3	26 9	5 0	28 7	4 5	31 0	3 9	33 4	138
139	7 9	24 1	6 4	26 6	6 3	27 1	5 9	28 9	5 4	31 3	4 9	33 6	139
140	138 9	24 3	137 4	26 8	7 3	27 3	6 9	29 1	136 4	31 5	5 8	33 9	140
141	8,9	24,4	8.4	26,9	8,3	27.5	7.9	29.3	137,4	31,7	6.8	34,1	141
142	9 9	24 6	9 4	27 1	9 3	27 7	8 9	29 5	8 4	31 9	7 8	34 4	142
143	140 8	24 8	140 4	27 3	140 2	27 9	139 9	29 7	9 3	32 2	8 7	34 6	143
144	1 8	25 0	1 3	27 4	1 2	28 1	140 8	30 0	140 3	32 4	9 7	34 8	144
145	2 8	25 1	2 3	27 7	2 2	28 2	1 8	30 2	1 3	32 6	140 7	35 1	145
146	3 8	25 3	3 3	27 9	3 2	28 5	2 8	30 4	2 3	32 8	1 7	35 0	146
147	4 8	25 4	4 3	28 0	4 2	28 7	3 8	30 6	3 2	33 1	2 6	35 6	147
148	5 7	25 7	5 3	28 2	5 1	28 9	4 7	30 8	4 2	33 3	3 6	35 9	148
149	6 7	25 8	6 3	28 4	6 1	29 1	5 7	31 0	5 2	33 5	4 6	36 1	149
150	147 7	26 0	147 3	28 6	7 1	29 3	6 7	31 2	146 2	33 7	5 5	36 3	150
151	8,7	26,2	8,2	28,9	8,1	29.5	7.7	31.4	7,1	34,0	6,5	36,5	151
152	9 7	26 4	9 2	29 0	9 1	29 7	8 7	31 6	8 1	34 2	7 5	36 8	152
153	150 7	26 5	150 2	29 2	150 0	29 9	149 6	31 8	9 1	34 4	8 5	37 0	153
154	1 7	26 7	1 2	29 4	1 0	30 0	150 6	32 0	150 1	34 6	9 4	37 3	154
155	2 6	26 9	2 1	29 6	2 0	30 2	1 6	32 2	1 0	34 9	150 4	37 5	155
156	3 6	27 1	3 1	29 8	3 0	30 6	2 6	32 4	2 0	35 1	1 4	37 7	156
157	4 6	27 2	4 1	30 0	4 0	30 6	3 6	32 7	3 0	35 3	2 3	38 0	157
158	5 6	27 4	5 1	30 1	4 9	30 8	4 5	32 9	4 0	35 5	3 3	38 2	158
159	6 6	27 6	6 1	30 3	5 9	31 0	5 5	33 1	4 9	35 8	4 3	38 5	159
160	157 6	27 7	157 1	30 5	156 9	31 2	6 5	33 3	155 9	36 0	155 2	38 7	160
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	80 Deg.		79 deg.		7 Points		78 Deg.		77 deg.		76 Deg.		

Diff.	1 P, 1 q,		15 Deg,		16 Deg.		1 Pt. 1h,		17 Deg.		18 Deg.		Diff.
	Lat.	deg.	Lat,	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep,	Lat.	dep,	
1	01,0	00,2	01,0	00,3	01,0	00,3	01,0	00,3	01,0	00,3	00,9	00,3	1
2	01 9	00 5	01 9	00 5	01,9	00 5	01 9	00 6	01 9	00 6	01 9	00 6	2
3	02 9	00 7	02 9	00 8	02 9	00 8	02 9	00 9	02 9	00 9	02 8	00 9	3
4	03 9	01 0	03 9	01 0	03 8	01 1	03 8	01 2	03 8	01 2	03 8	01 2	4
5	04 8	01 2	04 8	01 3	04 8	01 4	04 8	01,5	04,8	01,5	04 8	01 5	5
6	05 8	01,5	05 8	01 5	05 7	01,6	05 8	01 7	05 7	01 7	05 7	01,9	6
7	06,8	01 7	06,8	01,8	06.7	01,9	06,7	02 0	06,7	02 0	06,7	02 2	7
8	07 8	01 9	07 7	02 1	07 7	02,2	07 7	02,3	07 6	02 3	07 6	02 5	8
9	08 7	02 2	08 7	02 3	08 6	02 5	08 6	02 6	08 6	02,6	08 6	02.8	9
10	09 7	02 4	09 7	02 6	09 6	02 8	09 6	02 9	09 6	02 9	09 6	03 1	10
11	10,7	02,8	10 6	02,8	10 6	03,0	10 5	03 2	10 5	03,2	10 5	03 4	11
12	11 6	02 9	11,6	03 1	11,5	03,3	11,5	03,5	11,5	03 5	11,4	03 7	12
13	12 6	03 2	12 6	03 4	12 5	03 6	12 4	03 8	12 4	03 8	12 4	04,0	13
14	13 6	03 4	13 5	03 6	13 5	03 9	13 4	04 1	13 4	04 1	13 3	04,3	14
15	14 5	03,6	14 5	03 9	14 4	04,1	14 4	04,4	14 3	04 4	14 3	04 6	15
16	15 5	04 0	15 5	04 1	15 4	04 4	15 3	04 6	15 3	04 7	15,2	04 9	16
17	16,5	04 2	16,4	04,4	16,	04 7	16,3	04 9	16,3	05,0	16 2	05,2	17
18	17 5	04 4	17 4	04 7	17 3	05 0	17 2	05 2	17 2	05 3	17 1	05 6	18
19	18 4	04 6	18 4	04 9	18 3	05,2	18 2	05 5	18 2	05 5	18 1	05 9	19
20	19 4	04 9	19 3	05 2	19 2	05 5	19 1	05,8	19 1	05 8	19 0	06,2	20
21	20 4	05,1	20 3	05,4	20 2	05,8	20 1	06 1	20,1	06 1	20,0	06 5	21
22	21,3	05 3	21,2	05 7	21,1	06,1	21,0	06 4	21 0	06,4	20 9	06 8	22
23	22 3	05 6	22 2	06 0	22,1	06 3	22 0	06,7	22 0	06,7	21 9	07 1	23
24	23 3	05 8	23 2	06 2	23,1	06 6	23 9	06 8	22 9	07,0	22 8	07 4	24
25	24 2	06 0	24 1	06 5	24,0	06 9	23 9	07 3	23 9	07,3	23 8	07,7	25
26	25 2	06 3	25 1	06,7	25,9	07,2	24 9	07 5	24 9	07.6	24 7	08 0	26
27	26,1	06,6	26,1	07,0	26,9	07,4	25 8	07,8	25,8	07,9	25,7	08 3	27
28	27 2	06 8	27 0	07 2	26,9	07,7	26,8	08 1	26 8	08,2	26 6	08,6	28
29	28 1	07,0	28 0	07 5	27,8	08 0	27 8	08 4	27 7	08,5	27 6	09.0	29
30	29 1	07,3	29 0	07 8	28,8	08,3	28 7	08 7	28 7	08,8	28 5	09 3	30
31	30 1	07,5	29 9	08,0	29,8	08,5	29 7	09,0	29 6	09,1	29 5	09,6	41
32	31,0	07 9	30 9	08 3	30,7	08 8	30 6	09 3	30,6	09,4	30,4	10 0	42
33	32 0	08,0	31,9	08,5	31,7	09 1	31,6	09 6	31 6	09,6	31 4	10 2	43
34	33 0	08,3	32 8	08,8	32.7	09 4	32 5	09 9	32 5	09 9	32 3	10 5	44
35	33 9	08,5	33 8	09 0	33,6	09,6	33 5	10 2	33 5	10 2	33 3	10 8	45
36	34 9	08 7	34 8	09 3	34,6	09,9	34 4	10 4	34 4	10,5	34 2	11,1	46
37	35 9	09,0	35 7	09 6	35,6	10 2	35,4	10 7	35.4	10 8	35,2	11 4	47
38	36,9	09,2	36.7	09 8	36,5	10 5	36 4	11 0	36 3	11,1	36 1	11 7	48
39	37 8	09,8	37 7	10 1	37,5	10,7	37 3	11,3	37 3	11 4	37 1	12 0	49
40	38 8	09,7	38 6	10,3	38,4	11,0	38 2	11 6	38 2	11,7	38 0	12 4	40
Diff.	dep	Lat.	dep,	Lat.	dep,	Lat.	dep	Lat.	dep,	Lat,	dep,	Lat.	Diff.
	6 Pt, 3 q,		75 Deg.		74 Deg,		6 Pts, 1h,		73 Deg.		72 Deg.		

Dist.	1 P, 1 q.		15 Deg,		16 Deg,		1 Pt, 1 h,		17 Deg.		18 Deg.		Dist.
	Lat.	dep.	Lat.	dep.	Lat,	dep.	Lat,	dep,	Lat,	dep,	Lat,	dep,	
41	39,8	10,0	39,6	10.6	39.4	11,3	39,2	11,9	39,2	12,0	39,0	12.7	41
42	40 7	10 2	40 6	10 9	40 3	11 6	40 2	12 2	40 2	12 3	39 9	13 0	42
43	41 7	10 4	41 5	11 1	41 3	11 8	41 1	12 5	41 1	12 6	40 9	13 3	43
44	42 7	10 7	42 5	11 5	42 2	12 1	42 1	12 8	42 1	12 9	41 8	13 6	44
45	43 6	10 9	43 5	11 7	43 2	12 4	43 1	13 1	43 0	13 1	42 8	13 9	45
46	44 6	11 2	44 4	11 9	44 2	12 7	44 0	13 3	44 0	13 4	43 7	14 2	46
47	45 6	11 4	45 4	12 2	45 2	12 9	45 0	13 6	45 0	13 6	44 7	14 5	47
48	46 6	11 7	46 4	12 4	46 1	13 2	45 9	13 9	45 9	14 0	45 6	14 8	48
49	47 5	11 9	47 4	12 7	47 1	13 5	46 9	14 2	46 9	14 3	46 6	15 1	49
50	48 5	12 1	48 3	12 9	48 1	13 8	47 8	14 5	47 8	14 6	47 5	15 4	50
51	49,5	12,4	49.3	13,2	49,0	14,0	48,8	14,8	48,8	14,9	48,5	15.8	51
52	50 4	12 6	50 2	13 5	50 9	14 3	49 7	15 1	49 7	15 2	49 4	16 1	52
53	51 4	12 9	51 2	13 7	50 9	14 6	50 7	15 3	50 7	15 5	50 4	16 4	53
54	52 4	13 1	52 2	14 0	51 9	14 9	51 7	15 0	51 7	15 7	51 3	16 7	54
55	53 3	13 4	53 1	14 2	52 8	15 2	52 6	16 7	52 6	16 1	52 3	17 0	55
56	54 3	13 6	54 1	14 5	53 8	15 4	53 6	16 2	53 5	16 4	53 3	17 3	56
57	55 3	13 8	55 1	14 8	54 8	15 7	54 5	16 5	54 5	16 7	54 2	17 6	57
58	56 2	14 1	56 0	15 0	55 7	16 0	55 5	16 8	55 5	17 0	55 2	17 9	58
59	57 2	14 3	57 0	15 3	56 7	16 3	56 5	17 1	56 4	17 2	56 1	18 2	59
60	58 2	14 6	58 0	15 5	57 7	16 5	57 4	17 4	57 4	17 5	57 1	18 5	60
61	59,2	14,8	58.9	15,8	58.6	16,8	58.4	17.7	58,3	17,8	58,0	18,8	61
62	60 1	15 1	59 9	16 1	59 6	17 1	59 3	18 0	59 3	18 1	59 0	19 2	62
63	61 1	15 3	60 8	16 3	60 5	17 4	60 3	18 3	60 2	18 4	59 9	19 5	63
64	62 1	15 5	61 8	16 6	61 5	17 6	61 2	18 6	61 2	18 7	60 9	19 8	64
65	63 0	15 8	62 8	16 8	62 5	17 9	62 2	18 9	62 1	19 0	61 8	20 1	65
66	64 0	16 0	63 7	17 1	63 4	18 2	63 2	19 2	63 1	19 3	62 8	20 4	66
67	65 0	16 3	64 7	17 4	64 4	18 5	64 1	19 4	64 1	19 6	63 7	20 7	67
68	66 0	16 5	65 7	17 6	65 4	18 7	65 1	19 7	65 0	19 9	64 7	21 0	68
69	66 9	16 8	66 6	17 9	66 3	19 0	66 0	20 0	66 0	20 2	65 6	21 3	69
70	67 9	17 0	67 6	18 1	67 3	19 3	67 0	20 3	66 9	20 5	66 6	21 6	70
71	68,9	17.2	68,6	18,3	68,2	19,6	67,9	20.6	67,9	20,8	67,5	21.9	71
72	69 8	17 5	69 5	18 6	69 2	19 8	68 9	20 9	68 8	21 0	68 5	22 2	72
73	70 8	17 7	70 5	18 9	70 2	20 1	69 8	21 2	69 8	21 3	69 4	22 6	73
74	71 8	18 0	71 5	19 1	71 1	20 4	70 8	21 5	70 8	21 6	70 4	22 9	74
75	72 7	18 2	72 4	19 4	72 1	20 7	71 7	21 8	71 7	21 9	71 3	23 2	75
76	73 7	18 5	73 4	19 7	73 0	20 9	72 7	22 1	72 7	22 2	72 3	23 5	76
77	74 7	18 7	74 4	19 9	74 0	21 2	73 7	22 3	73 6	22 5	63 2	23 8	77
78	75 7	18 9	75 3	20 2	78 0	21 5	74 6	22 6	74 6	22 8	74 2	24 1	78
79	76 6	19 2	76 3	20 4	75 9	21 8	75 6	22 9	75 5	23 1	75 1	24 4	79
80	77 6	19 4	77 3	20 7	76 9	22 0	76 6	23 2	76 5	23 4	76 1	24 7	80
Dist.	dep.	Lat.	dep	Lat,	dep.	Lat.	dep,	Lat,	dep,	Lat,	dep.	Lat.	Dist.
	6 P. 3 q.		75 Deg,		74 Deg.		6 Pt. 1 h,		73 deg.		72 Deg,		

Dif.	1 Pt, 1 q,		15 Deg.		16 Deg,		1 Pt, 1 h,		17 Deg.		18 deg.		Dif.
	Lat,	Lat,	Lat,	dep.	Lat.	dep,	Lat,	dep.	Lat,	dep,	Lat.	dep,	
81	78.6	19.7	78.2	21,0	77,9	22.3	77,5	23,5	77,5	23.7	77,0	25,0	81
82	79 5	19 9	79 2	21 2	78 8	22 6	78 4	23 8	78 4	24 0	78 0	25 3	82
83	80 5	20 3	80 2	21 5	79 8	22 9	79 4	24 1	79 4	24 3	78 9	25 6	83
84	81 5	20 4	81 1	21 7	80 8	23 1	80 4	24 4	80 3	24 5	79 9	26 0	84
85	82 4	20 7	82 1	22 0	81 7	23 4	81 4	24 7	81 3	24 8	80 8	26 3	85
86	83 4	20 9	83 1	22 3	82 7	23 7	82 3	25 0	82 2	25 1	81 8	26 6	86
87	84 4	21 2	84 0	22 5	83 6	24 0	83 3	25 2	83 2	25 4	82 7	26 9	87
88	85 4	21 4	85 0	22 8	84 6	24 2	84 2	25 5	84 1	25 7	83 7	27 2	88
89	86 3	21 6	86 0	23 0	85 6	24 5	85 2	25 8	85 1	26 0	84 6	27 5	89
90	87 3	21 9	86 9	23 3	86 5	24 8	86 1	26 1	86 1	26 3	85 6	27 8	90
91	88,3	22,1	87.9	23,5	87,5	25,1	87.1	26.5	87.0	26,6	86,5	28,1	91
92	89 3	22 4	88 9	23 8	88 4	25 3	88 0	26 7	88 0	26 9	87 5	28 4	92
93	90 2	22 6	89 8	24 1	89 4	25 6	89 0	27 0	88 9	27 2	88 4	28 7	93
94	91 2	22 8	90 8	24 3	90 4	25 9	90 0	27 3	89 9	27 5	89 4	29 0	94
95	92 1	23 1	91 8	24 6	91 3	26 2	90 9	27 6	90 8	27 8	90 3	29 3	95
96	93 1	23 3	92 7	24 8	92 3	26 4	91 9	27 9	91 8	28 1	91 3	29 7	96
97	94 1	23 6	93 7	25 1	93 3	29 7	92 8	28 2	92 8	28 4	92 3	30 0	97
98	95 1	23 8	94 7	25 3	94 2	27 0	93 8	28 4	93 7	28 6	93 2	30 3	98
99	96 0	24 1	95 6	25 6	95 2	27 3	94 7	28 7	94 7	28 9	94 2	30 6	99
100	97 0	24 3	96 6	25 9	96 1	27 6	95 7	29 0	95 6	29 2	95 1	30 9	100
101	98,0	24.6	97.6	26.1	97.1	27,8	96,7	29.3	96.6	29.5	96,1	31.2	101
102	98 9	24 8	98 5	26 4	98 0	28 1	97 6	29 6	97 5	29 8	97 0	31 5	102
103	99 9	25 0	99 5	26 7	99 0	28 4	98 6	29 9	98 5	30 1	98 0	31 8	103
104	100 9	25 3	100 5	26 9	100 0	28 7	99 5	30 2	99 4	30 4	98 9	32 1	104
105	1 9	25 5	1 4	27 2	101 9	28 9	100 5	30 5	100 4	30 7	99 9	32 4	105
106	2 8	25 8	2 4	27 4	1 9	29 2	1 4	30 7	1 4	31 0	100 8	32 8	106
107	3 8	26 0	3 4	27 7	2 8	29 5	2 4	31 0	2 8	31 3	1 8	33 1	107
108	4 8	26 2	4 3	28 0	3 8	29 8	3 4	31 3	3 3	31 6	2 7	33 4	108
109	5 7	26 5	5 3	28 2	4 8	30 0	4 3	31 6	4 2	31 9	3 7	33 7	109
110	6 7	26 7	6 2	28 5	5.7	30 3	5 3	31 9	5 2	32 2	4 6	34 0	110
111	107,7	27.0	7,2	28.7	6,7	30,6	6,2	32.1	6,1	32.4	5.6	34.3	111
112	8 6	27 2	108 2	29 0	7 6	30 9	107 3	32 5	107 1	32 7	6 5	34 6	112
113	9 6	27 5	9 1	29 2	108 6	31 1	8 2	32 8	8 1	33 0	7 5	34 9	113
114	110 6	27 7	110 1	29 5	9 6	31 4	9 1	33 1	9 0	33 3	8 4	35 2	114
115	1 6	27 9	1 1	29 8	110 5	31 7	110 1	33 4	1100	33 6	9 4	35 5	115
116	2 5	28 2	2 0	30 0	1 5	32 0	1 0	33 6	1109	33 9	110 3	35 8	116
117	3 5	28 4	3 0	30 3	1 5	32 2	2 0	33 9	1 9	34 2	1 3	36 2	117
118	4 5	28 7	4 0	30 5	2 4	32 5	2 9	34 2	2 8	34 5	2 2	36 5	118
119	5 4	28 9	5 9	30 8	3 4	32 8	3 9	34 5	3 8	34 8	3 2	36 8	119
120	1164	29 2	1169	31 1	4 3	33 1	1148	34 8	1147	35 1	1141	37 1	120
Dif.	dep,	Lat.	dep.	Lat.	dep,	Lat,	dep.	Lat,	dep.	Lat.	dep,	Lat,	Dif.
	6 Pt, 3q.		74 Deg.		74 deg,		6 Pts, 1 h,		73 deg.		72 Deg.		

Dif.	1 Pt. 1 q.		15 deg,		16 Deg,		1 Pt, 1 h,		17 Deg.		18 Deg,		Dif.
	Lat.	dep,	Lat,	dep,	Lat,	dep,	Lat.	dep	Lat,	dep.	Lat,	dep,	
121	117,4	29,4	116.9	31.3	116,3	33,3	115.8	35,1	115.7	35,4	115,1	37.4	121
122	118 3	29 6	117 8	31 6	117 3	33 6	116 8	35 5	116 7	35 7	116 0	37 7	122
123	119 3	29 9	118 8	31 8	118 2	33 9	117 7	35 7	117 6	36 0	117 0	38 0	123
124	120 3	30 1	97	32 1	119 2	34 2	118 7	36 0	86	36 2	75	38 3	124
125	1 3	30 4	120 7	32 4	120 1	34 4	96	36 3	95	36 5	89	38 6	125
126	2 2	30 6	1 7	32 6	1 1	34 7	120 6	36 5	120 5	36 8	98	38 9	126
127	3 2	30 9	2 7	32 9	2 1	35 0	1 6	37 6	1 4	37 1	120 8	39 2	127
128	4 2	31 1	3 6	33 1	3 0	35 3	2 5	37 1	2 4	37 4	1 7	39 6	128
129	5 1	31 3	4 6	33 4	4 0	35 6	3 5	37 4	3 4	37 7	2 7	39 9	129
130	126 1	31 6	125 6	33 6	124 9	35 8	4 4	37 7	124 3	38 0	3 6	40 2	130
131	7,1	31,8	5,5	33,9	5,9	36.1	5.4	38,0	5,3	38,3	4,6	40,5	131
132	8 1	32 1	6 5	34 2	6 9	36 4	6 3	38 3	6 2	38 6	5 5	40 8	132
133	9 0	32 3	8 5	34 4	7 8	36 7	7 3	38 6	127 2	38 9	6 5	41 1	133
134	130 0	32 6	9 4	34 7	8 8	36 9	8 2	38 9	8 1	39 2	7 4	41 4	134
135	1 0	33 8	130 4	34 9	9 8	37 2	9 2	39 2	9 1	39 1	8 4	41 7	135
136	1 9	33 0	1 4	35 2	130 7	37 5	130 2	39 4	130 0	39 8	9 3	42 0	136
137	2 9	33 3	2 3	35 5	1 7	37 8	1 1	29 7	1 0	40 0	130 3	42 3	137
138	3 9	33 5	3 3	35 7	2 6	38 0	2 1	40 0	2 0	40 3	1 2	42 6	138
139	4 8	33 8	4 3	36 0	3 6	38 3	3 0	40 3	2 9	40 6	2 2	43 0	139
140	135 8	34 0	135 2	36 2	4 6	38 6	4 0	40 6	133 9	40 9	3 1	43 3	140
141	6,8	34,3	6.2	36,5	5,5	38,9	4.9	40.9	4,8	41,2	4.1	43,6	141
142	7 7	34 5	7 2	36 7	6 5	39 4	5 9	41 2	5 8	41 5	5 0	43 9	142
143	8 7	34 7	8 1	37 0	7 4	39 3	6 9	41 5	6 8	41 8	6 0	44 2	143
144	9 7	35 0	9 1	37 3	8 4	39 7	7 8	41 8	137 7	42 1	6 9	44 5	144
145	140 7	35 2	140 1	37 5	9 4	40 0	8 8	42 1	8 7	42 4	7 9	44 8	145
146	1 6	35 5	1 0	37 8	140 3	40 2	139 7	42 3	9 6	42 7	8 8	45 1	146
147	2 6	35 5	2 0	38 0	1 3	40 5	140 7	42 6	140 6	43 0	9 8	45 4	147
148	3 6	35 7	3 0	38 3	2 3	40 8	1 6	42 9	1 5	43 3	140 7	45 7	148
149	4 5	36 2	4 9	38 6	3 2	41 1	2 6	43 2	2 5	43 6	1 7	46 0	149
150	145 5	36 5	145 9	38 8	4 2	41 3	3 5	43 5	143 4	43 8	2 7	46 4	150
151	6,5	36.7	5,8	39,1	5,1	41.6	4.5	43.8	4,4	44.1	3,6	46,6	151
152	7 4	36 9	6 8	39 3	6 1	41 9	5 5	44 1	5 3	44 4	4 6	47 0	152
153	8 4	37 2	7 8	39 6	7 1	42 2	6 4	44 4	6 3	44 7	5 5	47 3	153
154	9 4	37 4	8 7	39 9	8 0	42 4	7 4	44 7	7 3	45 0	6 5	47 6	154
155	150 4	37 7	9 7	40 1	9 0	42 7	8 3	45 0	8 2	45 3	7 4	47 9	155
156	1 3	37 9	150 7	40 4	9 9	43 0	149 2	45 2	9 2	45 6	8 4	48 2	156
157	2 3	38 2	1 6	40 6	150 9	43 3	150 2	45 5	150 1	45 9	9 3	48 5	157
158	4 3	38 4	2 6	40 9	1 9	43 5	1 2	45 8	1 1	46 2	150 3	48 8	158
159	5 2	38 6	3 6	41 1	2 9	43 8	2 2	46 1	2 0	46 5	1 2	49 1	159
160	156 2	38 9	154 5	41 4	153 8	44 1	3 1	46 4	153 0	46 8	152 2	49 4	160
Dif.	dep,	Lat,	dep.	Lat,	dep,	Lat.	dep.	Lat.	dep,	Lat.	dep,	Lat,	Dif.
	6 pts, 3q,		75 deg,		74 Deg,		6 Pts, 1 h,		73 deg.		72 Deg.		

Dist.	19 deg.		1 Pt, 3 q,		20 Deg,		21 Deg.		22 Deg.		2 Points,		Dist.
	Lat.	deg.	Lat,	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep,	Lat.	dep,	
1	00,9	00,3	00,9	00,3	00,9	00,3	00,9	00,4	00,9	00,4	00,9	00,4	1
2	01 9	00 6	01 9	00 7	01,9	00 7	01 9	00 7	01 8	00 7	01 8	00 8	2
3	02 8	01 0	02 8	01 0	02 8	01 0	02 8	01 1	02 8	01 1	02 7	01 0	3
4	03 8	01 3	03 8	01 3	03 8	01 4	03 8	01 4	03 7	01,6	03 8	01 5	4
5	04 7	01 6	04 7	01,7	04 7	01,7	04 7	01 8	04 6	01 9	04 6	01,9	5
6	05 7	01 9	05 6	02 0	05 6	02,0	05 7	02,0	05 6	02 2	05 6	02 3	6
7	06,6	02 3	06,6	02 4	06 6	02 4	06,6	02,4	06,5	02 6	06,5	02 7	7
8	07 5	02 6	07 5	02 6	07 5	02 7	07 5	02 7	07 4	03,0	07 4	03 1	8
9	08 5	02 9	08 5	03 0	08 5	03,1	08 5	03 2	08 2	03 4	08 3	03 4	9
10	09 5	03,3	09 4	03 4	09 4	03,4	09 4	03,6	09 2	03 7	09 2	03 8	10
11	10,4	03,6	10 4	03 7	10 3	03 8	10 3	03 9	10 2	04 1	10 2	04,2	11
12	11 3	03 9	11,3	0 ,0	11,3	04,1	11,3	04 3	11,1	04 5	11,1	04,6	12
13	12 3	04 2	12 2	04 4	12 2	04 4	12 1	04,7	12 0	04 9	12 0	05,0	13
14	13 3	04 6	13 2	04 7	13 2	04 8	13 1	05 0	13 0	05 2	12 9	05 4	14
15	14 2	04 9	14 1	05 1	14 1	05 1	14 0	05 4	13 9	05 6	13 9	05 7	15
16	15 1	05,2	15 1	05,4	15 0	05,4	14 9	05,8	14 8	06 0	14 8	06,1	16
17	6,1	05 5	16,0	05 7	16,0	05 8	15 9	06 1	15 8	06,1	15,7	06 5	17
18	17 0	05,9	16 9	06 1	16,9	06,3	16,8	06 4	16,7	06,7	16 6	06 8	18
19	18 0	06 1	17 9	06 4	17 9	06 5	17 7	06,8	17 6	07,1	17 6	07 3	19
20	18 9	06 5	18 9	06 7	18 8	06 8	18 7	07 2	18 5	07,5	18 5	07 6	20
21	19 9	06,8	19 8	07,1	19 7	07,2	19 6	07 5	19 5	07,9	19 4	08,0	21
22	20 8	07 2	20 7	07 4	20 7	07,5	20 5	07,9	20,4	08,2	20,3	08 4	22
23	21,7	07 5	21,7	07 7	21,6	07,9	21,5	08 2	21 3	08,6	21 2	08 8	23
24	22 7	07 8	22 6	08,1	22,6	08 2	22 4	08 6	22 2	09,0	22 2	09 2	24
25	23 6	08 1	23 5	08 4	23,5	08,5	23 4	09,0	23 2	09,4	23 1	09 6	25
26	24 6	08 8	24 5	08,8	24,5	08,8	24 3	09 3	24 1	09 7	24 0	09,5	26
27	25 5	08,7	25 5	09 1	25,4	09 2	25 3	09 7	25,0	10 1	25,0	10 3	27
28	26,5	09,0	26,4	09 4	26,4	09,6	26,2	10	26 0	10,8	26 0	10 7	28
29	27 4	09,4	27 4	09 8	27,3	09,8	27 2	10 3	27 0	10 9	26 9	11,1	29
30	28 4	09,8	28 3	10,1	28,3	10 1	28 1	10 7	28 9	11,2	27 0	11 4	30
31	29 3	10,1	29 3	10,4	29,1	10 6	29 1	11 1	28 9	11 6	28 6	11.9	31
32	30 3	10,4	30 2	10 8	30,0	10,9	30 0	11,5	29 8	12,0	29 6	12 2	32
33	31,2	10 7	31,1	11 1	31,0	11,3	31,0	11 8	30,8	12 4	30,5	12 6	33
34	32 2	11,1	32 1	11 5	31,9	11 6	31 9	12 2	31 7	12,7	31 4	13 0	34
35	33 1	11,4	33 0	11 8	32.9	12 0	32 9	12 5	32 7	13,1	32 4	13 4	35
36	34 0	11,7	33 9	12,1	33,8	12 3	33 8	12 9	33 6	13.5	33 3	13 8	36
37	35 0	12,1	34 9	12 5	34,8	12 6	34 8	13 3	34 5	13,9	34,2	14 2	37
38	35 9	12 4	35 8	12 8	35,7	13 0	35,7	13 6	35.5	14 2	35,1	14 5	38
39	36,9	12 6	36,8	13 1	36,7	13 3	36 7	14 0	36 4	14,6	36 0	14 9	39
40	37 8	13 0	37 7	13 5	37,6	13,7	37 6	14,4	37 4	15,0	36 c	15,3	40
Dist.	dep	Lat.	dep,	Lat.	dep,	Lat.	dep.	Lat.	dep,	Lat.	dep,	Lat.	Dist.
	71 deg,		6 P, 1 q,		70 Deg.		69 Deg,		68 Deg,		67 Deg,		

Dist.	19 Deg. Lat.	dep.	1 P. 3 q. Lat.	dep.	20 Deg. Lat.	dep.	21 Deg. Lat.	dep.	22 Deg. Lat.	dep.	2 Points, Lat.	dep.	Dist.
41	38,8	13,3	38,6	13,8	38.5	14,0	38,3	14,7	38,0	15,3	37,9	15.7	41
42	39 7	13 7	39 5	14 1	39 5	14 4	39 2	15 1	38 9	15 7	38 8	16 1	42
43	40 7	14 0	40 5	14 5	40 4	14 7	40 1	15 4	39 9	16 1	39 7	16 5	43
44	41 6	14 3	41 4	14 8	41 4	15 0	41 1	15 8	40 8	16 5	40 6	16 8	44
45	42 6	14 6	42 4	15 2	42 3	15 4	42 0	16 1	41 7	16 8	41 6	17 2	45
46	43 5	15 0	43 3	15 5	43 2	15 7	42 9	16 5	42 6	17 2	42 5	17 6	46
47	44 4	15 9	44 2	15 8	44 2	16 1	43 9	16 8	43 6	17 6	43 4	18 0	47
48	45 4	15 6	45 2	16 2	45 1	16 4	44 8	17 2	44 5	18 0	44 4	18 4	48
49	46 3	15 9	46 1	16 5	46 0	16 8	45 7	17 6	45 4	18 3	45 3	18 7	49
50	47 2	16 3	47	16 8	47 0	17 1	46 7	17 9	46 4	18 7	46 2	19 1	50
51	48,2	16,6	48.0	17,2	47,9	17,4	47,6	18,3	47,3	19,1	47,1	19,5	51
52	49 2	16 9	49 0	17 5	48 9	17 8	48 5	18 6	48 2	19 4	48 0	19 9	52
53	50 1	17 3	49 9	17 9	49 8	18 1	49 5	19 0	49 1	19 8	49 0	20 3	53
54	51 1	17 6	50 8	18 2	50 7	18 5	50 4	19 3	50 1	20 2	49 9	20 7	54
55	52 0	17 9	51 8	18 5	51 7	18 8	51 3	19 7	51 0	20 6	50 9	21 0	55
56	52 9	18 2	52 7	18 9	52 6	19 2	52 3	20 1	51 9	21 0	51 7	21 4	56
57	53 9	18 6	53 7	19 2	53 6	19 5	53 2	20 4	52 8	21 3	52 7	21 8	57
58	54 8	18 9	54 6	19 5	54 5	19 8	54 2	20 8	53 8	21 7	53 6	22 2	58
59	55 8	19 1	55 5	19 9	55 5	20 2	55 1	21 1	54 7	22 1	54 5	22 6	59
60	56 7	19 5	56 5	20 2	56 4	20 5	56 0	21 5	55 6	22 5	55 4	23 0	60
61	57,7	19,9	57.4	20,5	57.3	20,9	56,9	21,9	56,5	22,8	56,3	23,3	61
62	58 6	20 2	58 4	20 9	58 3	21 2	57 9	22 2	57 5	23 2	57 3	23 7	62
63	59 6	20 5	59 3	21 2	59 2	21 5	58 8	22 6	58 4	23 6	58 2	24 1	63
64	60 5	20 8	60 3	21 6	60 1	21 9	59 7	22 9	59 3	24 0	59 1	24 5	64
65	61 5	21 2	61 2	21 9	61 1	22 2	60 7	23 3	60 3	24 3	60 0	24 9	65
66	62 4	21 5	62 1	22 2	62 0	22 6	61 6	23 6	61 2	24 7	61 0	25 3	66
67	63 3	21 8	63 1	22 6	63 0	22 9	62 5	24 0	62 1	25 1	61 9	25 6	67
68	64 3	22 1	64 0	22 9	63 9	23 3	63 5	24 4	63 0	25 5	62 8	26 0	68
69	65 2	22 5	65 0	23 2	64 8	23 6	64 4	24 8	64 0	25 8	63 7	26 4	69
70	66 2	22 8	65 9	23 6	65 8	23 9	65 3	25 1	64 9	26 2	64 7	26 8	70
71	67.1	23.1	66,8	23,9	66,7	24,3	66,3	25.4	65,8	26,6	65,6	27.2	71
72	68 1	23 4	67 8	24 2	67 7	24 6	67 2	25 8	66 7	27 0	66 5	27 6	72
73	69 0	23 8	68 7	24 6	68 6	25 0	68 1	26 2	67 7	27 3	67 5	27 9	73
74	70 0	24 1	69 6	24 9	69 5	25 3	69 1	26 6	68 6	27 7	68 4	28 3	74
75	70 9	24 4	70 6	25 3	70 5	25 6	70 0	26 9	69 5	28 1	69 3	28 7	75
76	71 9	24 7	71 6	25 6	71 4	26 0	70 9	27 2	70 5	28 5	70 2	29 1	76
77	72 8	25 1	72 5	25 9	72 4	26 3	71 9	27 6	71 4	28 8	71 1	29 5	77
78	73 7	25 4	73 4	26 3	73 3	26 7	72 8	27 9	72 3	29 2	72 1	29 8	78
79	74 7	25 6	74 4	26 6	74 2	27 0	73 7	28 3	73 2	29 6	63 0	30 2	79
80	75 6	26 0	75 3	26 9	75 2	27 4	74 7	28 7	74 2	30 0	73 9	30 6	80
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	71 Deg.		6 P. 1 q.		70 Deg.		69 Deg.		68 deg.		6 Points.		

Dist.	19 Deg.		19 Pt.		20 Deg.		21 Deg.		22 Deg.		2 Points		Dist.
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
81	76.6	26.4	76.3	27,3	76,	27,9	75,0	28,0	75,1	30.	74,8	31.0	81
82	77 5	26 7	77 2	27 6	77 1	28 0	76 5	29 4	76 1	30 7	75 8	31 4	82
83	78 5	27 0	78 2	28 0	78 0	28 4	77 5	29 7	77 0	31 1	76 7	31 8	83
84	79 4	27 3	79 1	28 3	78 9	28 7	78 4	30 1	77 9	31 5	77 6	32 1	84
85	80 4	27 7	80 1	28 6	79 9	29 1	79 3	30 5	78 8	31 8	78 6	32 5	85
86	81 3	28 0	81 0	29 0	80 8	29 4	80 3	30 8	79 7	32 2	79 4	32 9	86
87	82 3	28 3	81 9	29 3	81 8	29 7	81 2	31 2	80 7	32 6	80 4	33 3	87
88	83 2	28 6	82 8	29 6	82 7	30 1	82 1	31 5	81 6	33 0	81 3	33 7	88
89	84 1	29 0	83 8	30 0	83 6	30 4	83 1	31 9	82 5	33 3	82 2	34 1	89
90	85 1	29 3	84 7	30 3	84 6	30 8	84 0	32 3	83 4	33 7	83 1	34 4	90
91	86,0	29.6	85.7	30.7	85,5	31.1	84 9	32.6	84.4	34.1	84,1	34.8	91
92	87 0	29 9	86 6	31 0	86 4	31 5	85 9	33 0	85 3	34 5	85 0	35 2	92
93	88 0	30 3	87 6	31 3	87 4	31 8	86 8	33 3	86 2	34 8	85 9	35 6	93
94	89 9	30 6	88 5	31 7	88 3	32 1	87 7	33 7	87 2	35 2	86 8	36 0	94
95	89 8	30 9	89 5	32 0	89 3	32 5	88 7	34 0	88 1	35 0	87 8	36 4	95
96	90 8	31 3	90 4	32 4	90 2	32 8	89 6	34 4	89 0	35 9	88 7	36 7	96
97	91 7	31 6	91 3	32 7	91 1	33 2	90 5	34 8	89 9	36 3	89 6	37 1	97
98	92 7	31 9	92 3	33 0	92 1	33 5	91 5	35 1	90 9	36 7	90 5	37 5	98
99	93 6	32 3	93 2	33 4	93 0	33 9	92 4	35 5	91 8	37 1	91 5	37 9	99
100	94 5	32 6	94 2	33 7	94 0	34 2	93 4	35 8	92 7	37 5	92 1	38 3	100
101	95,5	32,9	95.	34,0	94.9	34,5	94,3	36.2	93.6	37,8	93,1	38,7	101
102	96 4	33 2	96 0	34 4	95 9	34 9	95 3	36 6	94 6	38 2	94 2	39 0	102
103	97 4	33 5	97 0	34 7	96 8	35 2	96 2	36 9	95 5	38 6	95 2	39 4	103
104	98 3	33 9	98 9	35 0	97 7	35 6	97 1	37 3	96 4	39 0	96 1	39 7	104
105	99 3	34 2	99 9	35 4	98 7	35 9	98 1	37 6	97 4	39 3	97 0	40 2	105
106	100 2	34 5	99 8	35 7	99 6	36 3	99 0	38 0	98 3	39 7	97 9	40 6	106
107	1 2	34 8	100 7	36 0	100 5	36 6	99 9	38 3	99 2	40 1	98 9	41 1	107
108	2 1	35 2	1 7	36 4	101 5	36 9	100 9	38 7	100 1	40 5	99 8	41 3	108
109	3 1	35 5	2 6	36 7	2 4	37 3	1 8	39 1	1 1	40 8	100 7	41 7	109
110	4 0	35 8	3 6	37 0	3 4	37 6	2 7	39 4	2 0	41 2	1 6	42 1	110
111	4,9	36 1	4,5	37.4	4,3	38,0	3.6	39.8	2.9	41.6	2.6	42,5	111
112	5 9	36 4	5 2	37 7	5 2	38 3	4 6	40 1	3 8	42 0	3 5	42 9	112
113	6 8	36 8	6 2	38 1	6 2	38 6	5 5	40 5	4 8	42 3	4 4	43 3	113
114	107 8	37 1	7 1	38 4	7 1	39 0	6 5	40 9	5 7	42 7	5 3	43 6	114
115	8 7	37 4	8 0	38 8	8 1	39 3	107 4	41 2	6 6	43 1	6 3	44 0	115
116	9 7	37 8	1 0	39 1	109 0	39 7	8 3	41 6	107 6	43 5	7 2	44 4	116
117	110 6	38 1	109 9	39 4	9 9	40 0	9 3	41 9	8 5	43 8	8 1	44 8	117
118	1 6	38 4	110 9	39 7	110 9	40 4	110 2	42 3	9 4	44 2	9 0	45 2	118
119	2 5	38 7	1 8	40 1	1 8	40 7	1 1	42 6	110 3	44 6	119 9	45 5	119
120	3 5	39 1	112 7	40 4	2 8	41 0	112 1	43 0	111 3	45 0	110 7	45 9	120
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	1 Deg.		6 Pt. 19.		70 deg.		69 Deg.		68 deg.		6 Points.		

Dist.	19 deg		1 pt, 39,		20 Deg,		21 deg.		22 Deg.		2 Points		Dist.
	Lat.	dep.	Lat,	dep,	Lat,	dep,	Lat.	dep.	Lat,	dep.	Lat,	dep,	
121	114 5	39 4	113 7	40 8	113,7	41	113 0	43 4	112 2	45 3	111,8	46,	121
122	115 3	39 7	114 6	41 1	114 0	41 7	113 9	43 7	113 1	45 7	112 7	46	122
123	116 3	40 0	115 5	41 4	115 6	42 1	114 9	44 1	114 0	46 1	113 6	47 1	123
124	117 2	40 4	116 5	41 8	116 9	42 4	115	44 4	115 0	46 5	114 6	47 5	124
125	118 2	40 7	117 4	42 1	117	42 8	116 7	44 8	115 9	46 8	115	47 8	125
126	119 1	41 0	118 4	42 1	118 4	43	117	45 2	116 8	47 2	116	48 2	126
127	120 1	41	94	42 8	119 3	43 4	118 6	43 5	117 8	47 6	117	48 6	127
128	1 0	41 7	120	43 1	120 3	43 8	95	45 9	87	47 9	83	49 0	128
129	20	42 0	1 2	43 4	1 2	44 1	120 5	46 2	96	48 3	92		129
130	122 9	42 3	2 1	43 8	2 2	44 5	1 4	46 6	120 5	48 7	120	49 8	130
131	123,0	42,7	3,1	44,1	3,	44,	2,3	47,0	1,5	49,	1,0	50,1	131
132	4 8	43 0	4 0	44 5	4 0	45 1	3 3	47 3	2	49 4	2	50 5	132
133	5 7	43 3	5 0	44 8	125 0	45 5	4 2	47 7	3 8	49 8	122	50 9	133
134	6 7	43 6	6 9	45 1	5 9	45 8	5 1	48 0	124 2	50 2	3 9	51 3	134
135	7 6	44 0	7 9	45 5	6 9	46 2	6 1	48 4	5 2	50 6	4 8	51 7	135
136	8 6	44 3	8 0	45 8	7 8	46 5	7 0	48 7	6 1	50 9	5 7	52 0	136
137	9 5	44 6	9 0	46 1	8 7	46 9	127 9	49 1	127 0	51 3	6 6	52 4	137
138	130 5	44 9	129 9	46 5	9 7	47 2	8 9	49 5	8 0	51 7	7 5	52 8	138
139	1 4	45 3	130 9	46 8	130 6	47 5	9 8	49 8	128 9	52 1	8 4	53 2	139
140	2 4	45 6	1 8	47 2	1 6	47 9	130 7	50 2	9 8	52 4	9 4	53 6	140
141	3 3	45 9	2.8	47 5	2,	48 2	1,7	50,5	130,	52,8	130,3	54,0	141
142	4 3	46 2	3 7	47 8	3 4	48 6	2 6	50 9	1 7	53 2	1 2	54 3	142
143	135 2	46 6	4 0	48 2	4 4	48 9	3 5	51 3	2 6	53 6	2 1	54 7	143
144	6 1	46 9	135 6	48 5	5 3	49 2	4 5	51 6	133 5	53 9	3 0	55 1	144
145	7 1	47 2	6 5	48 9	6 3	49 6	5 4	52 0	4 4	54 3	134 0	55 5	145
146	8 0	47 5	7 5	49 2	7 2	49 9	6 3	52 3	5 4	54 7	4 9	55 9	146
147	9 0	47 9	8 4	49	8 1	50 3	7 3	52 7	6 3	55 1	5 8	56 3	147
148	139 9	48 2	9 3	49 8	9 1	50 6	8 2	53 0	137 2	55 4	6 7	56 6	148
149	140 9	48 7	140 3	50 2	140 0	51 1	139 2	53 4	8 2	55 8	7 7	57 0	149
150	1 8	48 8	1 2	50 5	141 0	51 3	140 1	53 8	9 1	56 2	8 6	57 4	150
151	2,8	49,2	2,2	50,9	1,9	51,6	141 0	54,1	140,0	56,6	9,5	57,8	151
152	3 7	49 5	3 1	51 2	2 8	52 0	1 9	54 5	140 0	56 9	140 4	58 2	152
153	4 7	49 8	4 0	51 5	3 7	52 3	2 9	54 8	1 9	57 3	1 4	58 6	153
154	145 6	50 1	145 0	51 9	4 6	52 7	3 8	55 2	2 8	57 7	2 3	58 9	154
155	6 5	50 5	5 9	52 2	5 6	53 1	4 7	55 6	143 7	58 1	3 2	59 3	155
156	7 5	50 8	6 9	52 5	6 6	53 4	5 7	55 9	4 6	58 4	4 1	59 7	156
157	8 4	51 1	7 8	52 9	7 5	53 7	6 6	56 3	5 6	58 8	5 1	60 1	157
158	9 4	51 4	8 8	53 2	8 5	54 0	7 5	56 6	6 5	59 2	6 0	60 5	158
159	150 3	51 8	9 7	53 6	9 5	54 4	8 5	57 0	7 4	59 6	146 9	60 9	159
160	151 3	52 1	150 6	53 9	150 4	54 7	149 4	57 3	148 4	59 9	147 8	61 2	160
Dist.	dep,	Lat,	dep.	Lat,	dep,	Lat.	dep.	Lat.	dep,	Lat,	dep,	Lat,	Dist.
	71 Deg.		6 Pts. 1q.		70 Deg,		69 deg,		68 deg.		6 Points.		

Dif.	23 deg.		24 Deg.		25 Deg.		2P, 1 q.		26 Deg.		27 Deg.	
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.
1	00,9	00,4	00,9	00,4	00,9	00,4	00,9	00,4	00,9	00,4	00,9	00,4
2	01 8	00 8	01 8	00 8	01,8	00 8	01 8	00,9	01 8	00 9	01 8	00 9
3	02 8	01 2	02 8	01 2	02 7	01 3	02 7	01 3	02 7	01 3	02 7	01 4
4	03 7	01 6	03 6	01,6	03 6	01 7	03 6	01 7	03 6	01,7	03 6	01 5
5	04 6	01 9	04 6	02 0	04 5	02,1	04 5	02,1	04,5	02 2	04 5	02 3
6	05 5	02 3	05 5	02 4	05 4	02 4	05 4	02,5	05 4	02 6	05 3	02 7
7	06,4	02 7	06,4	02 8	06.3	02 8	06,3	03 0	06,3	03,0	06,2	03 2
8	07 4	03,1	07 3	03 2	07 2	03,2	07 2	03,4	07 2	03 5	07 1	03 6
9	08 3	03,5	08 2	03 7	08 2	03,7	08 2	03 8	08 1	03 9	08 0	04,1
10	09 2	03 9	09 1	04,1	09 1	04,1	09 1	04 2	09 0	04 4	08 9	04,5
11	10,1	04 3	10 0	04 5	10 0	04 6	09 9	04,7	09 8	04 8	09 8	05,0
12	11 0	04 7	11,0	05 0	10,9	05 1	10 8	05 1	10 8	05 3	10 7	05 4
13	12 0	05,1	12 9	05 3	11,8	05,5	11,7	05 6	11,7	05 7	11,6	05 8
14	12 1	05 5	12 8	05,7	12 7	05 9	12 7	05,9	12 6	06 1	12 5	06,4
15	13 8	05,9	13 7	06 1	13 6	06,3	13 6	06 4	13 5	06,6	13 4	06 8
16	14 7	06 2	14 6	06 5	14 5	06 6	14 5	06 6	14 4	07,0	14 3	07 3
17	15 6	06 9	15 5	06 9	15 4	07,3	15 4	07 3	15,3	07,4	15,1	07 7
18	16,6	07 0	16 4	07,3	16,3	07,7	16,3	07 7	16 2	07,9	16 0	08,2
19	17 5	07 4	17 4	07 7	17,2	08 1	17 2	08 1	17 1	08,2	16 9	08 6
20	18 4	07 8	18 3	08,1	18 1	08,5	18 1	08 5	18 0	08,7	17 8	09 1
21	19 3	08 2	19 2	08 5	19,0	08,9	19 0	09,1	18 9	09,2	18,7	09,5
22	20 2	08 6	20 1	08,9	19 9	09 3	19,9	09 4	19 8	09,9	19 6	10 0
23	21,2	09,0	21,0	09 3	20 8	09,7	20 8	09 8	20,7	10 1	20 5	10 4
24	22 1	09,4	21,9	09 8	21,7	10 1	21,7	10 3	21 6	10,5	21 4	10,9
25	23 0	09,8	22 8	10,2	22,7	10,6	22 6	10 7	22 5	11,0	22 3	11 3
26	23 9	10,2	23 7	10,6	23,6	11,0	23 5	11,1	23 4	11 4	23 2	11 8
27	24 8	10,5	24 7	11 0	24,5	11 4	24 4	11 5	24 3	11 8	24 1	12 3
28	25 8	10 9	25 6	11 4	25,4	11 8	25 3	12 0	25,2	12,3	24 9	12 7
29	26,7	11,3	26,5	11 8	26,3	12 3	26 2	12 4	26 1	12 7	25,8	13 2
30	27 6	11,7	27 4	12,2	27,2	12 7	27 1	12 8	27 0	13,1	26 7	13 6
31	28 5	12,1	28 3	12 6	28,1	13 1	28 0	13 3	27 9	13,6	27 6	14 1
32	29 5	12 5	29 2	13 0	29,0	13 5	28,9	13 7	28 8	14,0	28 5	14 5
33	30 4	12 9	30 1	13 4	29,9	13,9	29 8	14 1	29 7	14 4	29 4	15 0
34	31,3	13 3	31,1	13 8	30,8	14 4	30 7	14,5	30,6	14,9	30,3	15,4
35	32 2	13,7	32 0	14 2	31,7	14 8	31 6	15 0	31 5	15,3	31 2	15 9
36	33 1	14 1	32 9	14 7	32.6	15,2	32 5	15 4	32 4	15 8	32 1	16 3
37	34 1	14 4	33 8	15 1	33,5	15 6	33 4	15 8	33 2	16,2	33 0	16 8
38	35 0	14 8	34 7	15 5	34,4	16 0	34 3	16,2	34 1	16,6	33,9	17 2
39	35 9	15,2	35 6	15 9	35,3	16,5	35,3	16,7	35.0	17 1	34,7	17 6
40	36,8	15,6	36.5	16 3	36,2	16,9	36 2	17 1	35 9	17 5	35 6	18,2
Dif.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.
	67 deg.		66 Deg.		65 Deg.		5 Pt, 3 q.		64 Deg.		63 Deg.	

Dif.	23 Deg.		24 Deg.		25 Deg.		2 P. 1 q.		26 Deg.		27 Deg.		Dif.
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
41	37,7	16.0	37,5	16.7	37 2	17,5	37,1	17.5	36,8	18,0	36.8	18.6	41
42	38 7	16 4	38 4	17 1	38 1	17 7	38 0	18 0	37 7	18 4	37 7	19 1	42
43	39 6	16 8	39 3	17 5	39 0	18 2	38 9	18 4	38 6	18 9	38 5	19 5	43
44	40 5	17 2	40 2	17 9	39 9	18 6	39 8	18 8	39 5	19 3	39 2	20 0	44
45	41 4	17 6	41 1	18 3	40 8	19 0	40 7	19 2	40 4	19 7	40 1	20 4	45
46	42 3	18 0	42 0	18 7	41 7	19 4	41 6	19 7	41 3	20 2	41 0	20 9	46
47	43 3	18 4	42 9	19 1	42 6	19 9	42 5	20 1	42 2	20 6	41 9	21 3	47
48	44 2	18 8	43 8	19 5	43 5	20 3	43 4	20 5	43 1	21 0	42 8	21 8	48
49	45 1	19 2	44 8	19 9	44 4	20 7	44 3	20 9	44 0	21 5	43 7	22 2	49
50	46 0	19 5	45 7	20 3	45 3	21 1	45 2	21 4	44 9	21 6	44 5	22 7	50
51	46,9	19,9	46.6	20,7	46,2	21,5	46,1	21.8	45,8	22,3	45,4	23,2	51
52	47 9	20 3	47 5	21 1	47 1	22 0	47 0	22 2	46 7	22 8	46 3	23 6	52
53	48 8	20 7	48 4	21 5	48 0	22 4	47 9	22 7	47 6	23 2	47 2	24 1	53
54	49 7	21 1	49 3	22 0	48 9	22 8	48 8	23 1	48 5	23 7	48 1	24 5	54
55	50 6	21 5	50 2	22 4	49 8	23 2	49 7	23 5	49 4	24 1	49 0	25 0	55
56	51 5	21 9	51 2	22 8	50 7	23 7	50 6	23 9	50 3	24 5	49 9	25 4	56
57	52 5	22 3	52 1	23 2	51 7	24 1	51 5	24 4	51 2	25 0	50 8	25 8	57
58	53 4	22 7	53 0	23 6	52 6	24 5	52 4	24 8	52 1	25 4	51 7	26 3	58
59	54 3	23 0	53 9	24 0	53 5	24 9	53 3	25 2	53 0	25 9	52 6	26 8	59
60	55 2	23 4	54 8	24 4	54 4	25 4	54 2	25 6	53 9	26 3	53 5	27 2	60
61	56,1	23,8	55.7	24,8	55.3	25,8	55.1	26,1	54,8	26,7	54,4	27.7	61
62	57 1	24 2	56 6	25 2	56 2	25 2	56 0	26 5	55 7	27 2	55 3	28 1	62
63	58 0	24 6	57 5	25 6	57 1	25 6	56 9	26 9	56 6	27 6	56 2	28 6	63
64	58 9	25 0	58 5	26 0	58 0	26 0	57 8	27 4	57 5	28 0	57 1	29 1	64
65	59 8	25 4	59 4	26 4	58 9	26 4	58 7	27 8	58 4	28 5	58 0	29 5	65
66	60 7	25 8	60 3	26 8	59 8	27 9	59 7	28 2	59 3	29 9	58 8	30 0	66
67	61 7	26 2	61 2	27 2	60 7	28 3	60 6	28 6	60 2	29 4	59 7	30 4	67
68	62 6	26 6	62 1	27 7	61 6	28 7	61 5	29 1	61 1	29 8	60 6	30 9	68
69	63 5	27 0	63 0	28 1	62 5	29 2	62 4	29 5	62 0	30 2	61 5	31 3	69
70	64 4	27 3	63 9	28 5	63 4	29 6	63 3	29 9	62 9	30 7	62 4	31 8	70
71	65,4	27,7	64,9	28,8	64,3	30,0	64,2	30,4	63,8	31,1	63,2	32.2	71
72	66 3	28 1	65 8	29 3	65 2	30 4	65 1	30 8	64 7	31 6	64 1	32 7	72
73	67 2	28 5	66 7	29 7	66 2	30 8	66 0	31 2	65 6	32 0	65 0	33 1	73
74	68 1	28 9	67 6	30 1	67 1	31 3	66 9	31 6	66 5	32 4	66 6	33 6	74
75	69 0	29 3	68 5	30 5	68 0	31 7	67 8	32 1	67 4	32 9	66 8	34 1	75
76	70 0	29 7	69 4	30 9	68 9	32 1	68 7	32 5	68 3	33 5	67 7	34 5	76
77	70 9	30 1	70 3	31 3	69 8	32 5	69 6	32 9	69 2	33 7	68 6	35 0	77
78	71 8	30 5	71 2	31 7	70 7	33 0	70 5	33 3	70 1	84 2	69 5	35 4	78
79	72 7	30 9	72 2	32 1	71 6	33 4	71 4	33 8	71 0	34 6	70 4	35 9	79
80	73 6	31 3	73 1	32 5	72 5	33 8	72 3	34 2	71 0	35 1	71 3	36 3	80
Dif.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dif.
	67 Deg.		66 Deg.		65 Deg.		5 P. 3 q.		64 deg.		63 Deg.		

Diff.	23 Deg.		24 Deg.		25 Deg.		2 Pt, 1 q,		26 Deg.		27 Deg.		Diff.
	Lat,	dep.	Lat,	dep.	Lat.	dep.	Lat,	dep	Lat,	dep,	Lat.	dep,	
81	74.6	31.6	74.0	32,9	73,4	34.2	73,2	34.6	72,8	35-5	72,2	36,8	81
82	75 5	320	749	33 3	74 3	34 9	74 1	35 1	73 7	35 9	73 1	37 2	82
83	76 4	32 4	75 8	33 8	75 2	35 1	75 0	35 5	74 6	36 4	74 0	37 7	83
84	77 3	32 8	76 7	34 2	76 1	35 5	75 9	35 9	75 5	36 8	74 9	38 1	84
85	78 2	33 2	77 6	34 6	77 0	35 9	76 8	36 3	76 4	37 3	75 8	38 6	85
86	79 2	33 6	78 6	35 0	77 9	36 3	77 7	36 8	77 3	37 7	76 7	39 0	86
87	80 1	34 0	79 5	35 4	78 8	36 8	78 6	37 2	78 2	38 1	77 6	39 5	87
88	81 0	34 4	80 4	35 8	79 7	37 2	79 5	37 6	79 1	38 6	78 5	40 0	88
89	81 9	34 8	81 3	36 2	80 7	37 6	80 5	38 1	80 0	39 0	79 4	40 4	89
90	82 8	35 2	82 2	36 6	81 6	38 0	81 4	38 5	80 9	39 3	80 3	40 9	90
91	83,7	35.6	83.1	37.0	82,5	38,5	82.3	38,9	81.8	39.8	81,1	4. 3	91
92	84 7	35 9	84 0	37 4	83 4	38 9	83 2	39 3	82 7	40 3	82 0	41 8	92
93	85 6	36 3	85 0	37 8	84 3	39 3	84 1	39 8	83 6	40 8	82 9	42 2	93
94	86 5	36 7	85 9	38 2	85 2	39 7	85 0	40 2	84 5	41 2	83 8	42 7	94
95	87 4	37 1	86 8	38 6	86 1	40 1	85 9	40 6	85 4	41 6	84 7	43 1	95
96	88 4	37 5	87 7	39 0	87 0	40 6	86 8	41 0	86 3	42 1	85 6	43 6	96
97	89 3	37 9	88 6	39 4	87 9	41 0	87 7	41 5	87 2	42 5	86 5	44 0	97
98	90 2	38 3	89 5	39 9	88 8	41 4	88 6	41 9	88 1	43 0	87 4	44 5	98
99	91 1	38 7	90 4	40 3	89 7	41 8	89 5	42 3	89 0	43 3	88 3	44 9	99
100	92 1	39 1	91 4	40 7	90 6	42 3	90 4	42 7	89 9	43 8	89 2	45 4	100
101	93,0	39,5	92,3	41,2	91,5	42,7	91,3	43.2	90.8	44,2	90,1	45.8	101
102	93 9	39 9	93 2	41 6	92 4	43 1	92 2	43 6	91 7	44 7	91 0	46 2	102
103	94 8	40 3	94 1	42 0	93 3	43 6	93 1	44 0	92 6	45 2	9. 9	46 6	103
104	95 7	40 7	95 0	42 4	94 2	44 8	94 0	44 5	93 5	45 6	92 8	47 1	104
105	96 6	41 2	95 9	42 9	95 1	44	94 9	44 9	94 4	46 1	93 6	47 5	105
106	97 6	41 4	96 8	43 5	96 1	44 8	95 8	45 3	95 3	46 5	94 4	48 1	106
107	98 5	41 4	97 7	43 1	97 0	45 2	96 7	45 7	96 2	46 9	95 3	48 6	107
108	99 4	42 2	98 7	43 9	97 9	45 6	97 6	46 2	97 1	47 3	96 2	49 0	108
109	100 3	42 6	99 6	44 3	98 8	46 1	98 5	46 6	98 0	47 8	97 1	49 5	109
110	1 3	43 0	100 5	44 7	99,7	46 5	99 4	47 0	98 9	48 2	98 0	49 9	110
111	2,2	43.4	1,4	45.1	100.6	40,9	100,3	47.5	99.8	48.7	98.9	50,4	111
112	3 1	43 8	2 3	45 6	101 5	47 3	1 2	47 9	100 7	49 1	99 8	50 8	112
113	4 0	44 1	3 2	46 0	2 4	47 8	2 1	48 3	1 6	49 5	100 7	51 3	113
114	4 9	44 9	4 1	46 4	3 3	48 2	103 0	48 7	2 5	50 0	1 6	51 8	114
115	5 9	44 9	5 1	46 8	4 2	48 6	3 9	49 2	3 4	50 4	2 5	52 2	115
116	6 8	45 3	6 0	47 2	5 1	49 0	4 8	49 6	4 3	50 9	3 4	52 7	116
117	107 7	45 7	106 9	47 6	6 0	49 4	5 8	50 0	5 2	51 3	4 3	53 1	117
118	8 6	46 1	7 8	48 0	106 9	49 9	6 7	50 4	6 1	51 7	5 2	53 6	118
119	9 5	46 5	8 7	48 4	7 8	50 3	7 6	50 9	107 0	52 0	6 1	54 0	119
120	110 5	46 9	109 6	48 8	108 8	50 7	108 5	51 3	107 9	52 6	107 0	54 5	120
Diff.	dep,	Lat,	dep.	Lat.	dep,	Lat,	dep.	Lat,	dep.	Lat.	dep,	Lat,	Diff.
	23 Deg,		66 Deg.		65 deg,		5 Pt, 3q.		64 deg.		63 Deg,		

Dist.	23 deg.		24 deg.		25 Deg,		2 pt, 1q.		26 Deg.		27 deg,		Dist.
	Lat.	dep,	Lat,	dep,	Lat,	dep,	Lat,	dep,	Lat,	dep.	Lat,	dep,	
121	111,5	47,3	110.3	49.2	109,7	51.1	109.4	51.7	108.8	53.0	108,8	53,0	121
122	112 3	47 7	111 4	49 6	110 6	51 6	110 3	52 2	109 7	53 5	109 7	53 5	122
123	113 2	48 1	112 4	50 0	111 5	52 0	111 2	52 6	110 6	53 9	110 0	53 9	123
124	114 1	48 4	113 3	50 4	112 4	52 4	112 1	53 0	111 5	54 4	110 9	54 4	124
125	115 1	48 8	114 2	50 8	113 3	52 8	113 0	53 8	112 4	54 8	111 8	54 0	125
126	116 0	49 2	115 1	51 2	114 2	53 2	113 9	53 9	113 2	55 2	112 7	55 2	126
127	116 9	49 6	116 0	51 7	115 1	53 7	114 8	54 8	114 1	55 7	113 6	55 7	127
128	117 8	50 0	116 9	52 1	116 0	54 1	115 7	54 7	115 0	56 1	114 5	56 1	12
129	118 7	50 4	117 8	52 5	116 9	54 5	116 6	55 2	115 9	56 6	115 4	56 6	129
130	119 7	50 8	118 8	52 9	117 8	54 9	117 5	55 6	116 8	57 0	116 3	57 8	1
131	120,6	51,2	9,7	53,3	118,7	55,4	118.4	56.0	117,7	57,4	117,2	57,5	131
132	1 5	51 6	120 6	53 7	119 6	55 8	9 3	56 4	8 6	57 9	8 1	57 9	132
133	2 4	52 0	1 5	54 1	120 5	56 2	120 2	56 7	9 5	58 3	9 0	58 3	133
134	123 3	52 4	2 4	54 5	1 4	56 6	1 1	57 3	120 4	58 7	119 9	58 7	134
135	4 3	52 7	3 3	54 9	2 4	57 1	122 0	57 7	1 3	59 2	120 8	59 2	135
136	5 2	53 1	4 2	55 3	3 3	57 5	2 9	58 2	2 2	59 6	1 7	59 6	136
137	6 1	53 5	5 1	55 7	4 2	57 9	3 8	58 6	3 1	60 1	2 6	60 1	137
138	127 0	53 9	6 1	56 1	5 1	58 3	4 7	59 0	124 0	60 5	3 5	60 5	138
139	7 9	54 3	127 0	56 5	6 0	58 7	5 6	59 4	5 9	60 9	4 4	60 9	139
140	8 9	54 7	7 9	56 9	126 9	59 2	6 5	59 9	6 8	61 4	5 3	61 4	140
141	9,8	55,1	8.8	57,3	7,8	59.6	7.4	60,3	127,7	61,8	6.2	61,8	141
142	130 7	55 5	129 7	57 8	8 7	60 0	8 4	60 7	127 6	62 3	7 1	62 3	142
143	1 6	55 9	130 6	58 2	9 6	60 4	9 3	61 1	128 5	62 7	8 0	62 7	143
144	2 6	56 3	1 5	58 6	130 5	60 9	130 2	61 6	9 4	63 1	128 9	63 1	144
145	3 5	56 7	2 4	59 0	1 4	61 3	1 1	62 0	130 3	63 6	129 8	63 6	145
146	4 4	57 0	3 4	59 4	2 3	61 7	2 0	62 4	1 2	64 0	130 7	64 0	146
147	135 3	57 4	4 3	59 8	3 2	62 1	2 9	62 9	2 1	64 4	1 6	64 4	147
148	6 2	57 8	135 2	60 2	4 1	62 5	3 8	63 3	133 0	64 9	2 5	64 9	148
149	7 2	58 2	6 1	60 6	135 0	63 0	4 7	63 7	3 9	65 3	3 4	65 3	149
150	8 1	58 6	7 0	61 0	5 9	63 4	5 6	64 1	4 8	65 8	4 3	65 8	150
151	9,0	59,0	137,9	61,4	6,9	63,8	6 5	64,6	5,7	66,2	5,2	66,2	151
152	139 9	59 4	8 9	61 8	7 8	64 2	7 4	65 0	6 6	66 6	6 1	66 6	152
153	140 8	59 8	9 8	62 2	8 7	64 7	8 3	65 4	137 5	67 1	7 0	67 1	153
154	1 7	60 2	140 7	62 6	9 6	65 1	139 2	65 5	8 4	67 5	138 9	67 5	154
155	2 7	60 6	1 6	63 0	140 5	65 5	140 1	66 3	9 3	68 0	8 8	68 0	155
156	3 6	61 9	2 5	63 4	1 4	65 9	141 0	66 7	140 2	68 4	9 7	68 4	156
157	4 5	61 3	3 4	63 9	2 3	66 3	1 9	67 1	1 1	68 8	140 6	68 8	157
158	5 4	61 7	4 3	64 3	3 2	66 8	2 8	67 6	2 0	69 3	1 5	69 3	158
159	6 3	62 1	5 2	64 7	4 1	67 2	3 7	68 0	142 9	69 7	2 4	69 7	159
160	147 3	62 5	146 1	65 1	145 0	67 6	144 6	68 4	143 8	70 1	143 0	70 1	160
Dist.	dep,	Lat.	dep.	Lat,	dep,	Lat.	dep.	Lat.	dep,	Lat.	dep,	Lat.	Dist.
	67 Deg.		66 deg.		65 Deg,		5 Pts. 3q.		6 deg		63 deg,		

Diff.	28 deg,		2 P, 1 h,		29 Deg,		30 Deg,		2 P. 3 q.		31 Deg.	
	Lat.	dep.	Lat,	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep,	Lat.	dep,
1	00,9	00,6	00,9	00,5	00,9	00,5	00,9	00,5	00,9	00,8	00,9	00,5
2	01 8	00 9	01 8	00 9	01,7	01 0	01 7	01 0	01 7	01 0	01 7	01 0
3	02 6	01 4	02 6	01 4	02 6	01 5	02 6	01 5	02 6	01,5	02 6	01 5
4	03 5	01 9	03 5	01,9	03 5	01 9	03 5	02,0	03 0	02 1	03 5	02 1
5	04 4	02 3	04 4	02 3	04 3	02,4	04 3	02,5	04,3	02 6	04 3	02 6
6	05 3	02 8	05 3	02 8	05 2	02 9	05 2	03 0	05 1	03,1	05 1	03 1
7	06,2	03,3	06,2	03 3	06.1	03,4	06,1	03,5	06,0	03 6	06,1	03 6
8	07 1	03,5	07 1	03 8	07,0	03,9	06,9	04 0	06.9	04 1	07 9	04,1
9	07 9	04 2	07 9	04,2	07 9	04,4	07 8	04,5	07 7	04 6	07 7	04,6
10	08 8	04 7	08 8	04 7	08 7	04 0	08 7	05 0	08 6	05 1	08 6	05,1
11	09 7	05,2	09 7	05 2	09 6	05 3	09 5	05 5	09 4	05 6	09 4	05 7
12	10,6	05 6	10 6	05,6	10,5	05,8	10 4	06 0	10 3	06 2	10 3	06,2
13	11 5	06 1	11,5	06 1	11,4	06,3	11,3	06 5	11,1	06,7	11,1	06 7
14	12 4	06 6	12 3	06 6	12 2	06 8	12 1	07 0	12 0	07,2	12 0	07 2
15	13 2	07 0	13 2	07,1	13 1	07,3	13 0	07 5	12 9	07,7	12 9	07 7
16	14 1	07 5	14 1	07 4	14 0	07,7	13 9	08 0	13 7	08,2	13 7	08,2
17	15 0	08 0	15,0	08,0	14 9	08 2	14 7	08 5	14 6	08,7	14 6	08 8
18	15 9	08 4	15 9	08 5	15 7	08,7	15 6	09,0	15,4	09,2	15,4	09 2
19	16,8	08 9	16 8	08,9	16,6	09 2	16,4	09 5	16 3	09,8	16 3	09,8
20	17 7	09,4	17 6	09 4	17 5	09,7	17 3	10 0	17 1	10 3	17 1	10 3
21	18 5	09,9	18 5	09 9	18 4	10 2	18 2	10 5	18 0	10,8	18 1	10 8
22	19 4	10,3	19 4	10,3	19,2	10,7	19 0	11,0	18 9	11,3	18,9	11 3
23	20 3	10,8	20 3	10,8	20 1	11,1	19,9	11 5	19 7	11 8	19 7	11.9
24	21,2	11,3	21,2	11 3	21,0	11 6	20 8	12 0	20,6	12,3	20 6	12 4
25	22 1	11,7	22,0	11 8	21 9	12 1	21,6	12 5	21 4	12 8	21 4	12 9
26	23 0	12,2	22 9	12,3	22,7	12 6	22 5	13 0	22 3	13,4	22 3	13 4
27	23 8	12 7	23 8	12 7	23,6	13 1	23 4	13 5	23 1	13.9	23 1	13 9
28	24 7	13 1	24 7	13 2	24,5	13 6	24 2	14 0	24 0	14,4	24 0	14 4
29	25 6	13,6	25 6	13 7	25,4	14 1	25 1	14,5	24 9	14 9	24 9	14 9
30	26,5	14 1	26,5	14 1	26,2	14 5	26 0	15 0	25,7	15,4	25,7	15 4
31	27 4	14 5	27 3	14 6	27,1	15,0	26 8	15 5	26 6	15 9	26 6	16 0
32	28 2	15,0	28 2	15 1	28,0	15 5	27 7	16,0	27 4	16,4	27 4	16 5
33	29 1	15,5	29 1	15 5	28,9	16 0	28 6	16,5	28 3	17 0	28 3	17 0
34	30 0	16 0	30 0	16 0	29,7	16,5	29 5	17 0	29 2	17 5	29 1	17 5
35	30,9	16 5	30 9	16 5	30,6	17,0	30,3	17 5	30,0	18,0	30,0	18,0
36	31,8	16 9	31,7	17 0	31,5	17 4	31 2	18 0	30,9	18 5	30 9	18,5
37	32 7	17,4	32 6	17 4	32,4	17 9	32 0	18 5	31 7	19 0	31 7	19,1
38	33 5	17,9	33 5	17 9	33,2	18,4	32 4	19,0	32 5	19,5	32 6	19 6
39	34 4	18 3	34 4	18 4	34,1	18,9	33 8	19 5	33 4	20 0	33,4	20 1
40	35 3	18 8	35 3	18 9	35,0	19 4	34 6	20 0	34 3	20,6	34,3	20 6
Diff.	dep.	Lat.	dep,	Lat.	dep	Lat.	dep.	Lat,	dep,	Lat,	dep,	Lat.
	62 deg,		5 Pt, 1 h,		61 Deg.		60 Deg,		5 P. 1 q.		59 Deg,	

Dist.	28 Deg.		2 P. 1 h.		29 Deg.		30 Deg.		2 P. 3 q.		31 D.	
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.
41	36,2	19,2	36,1	19,3	35 8	19,9	35,5	20.5	35,2	21,1	35.1	2
42	37 1	197	370	198	367	204	364	210	360	216	360	2
43	380	201	379	203	37 C	208	372	215	369	221	369	2
44	388	206	388	207	385	213	381	220	377	226	377	2
45	397	211	397	212	393	218	390	225	386	231	386	2
46	406	216	406	217	402	223	398	230	395	236	394	2
47	415	221	414	222	411	228	407	235	403	242	403	2
48	424	225	423	226	420	233	416	240	412	247	411	2
49	433	231	432	232	428	237	424	245	421	252	420	2
50	441	236	441	2.6	437	242	433	25 C	429	257	429	2
51	45,0	23,9	45.0	24.0	44,6	24,7	44,2	5 5	43,8	26,2	4 ,7	2
52	459	24 4	459	245	455	252	450	200	446	267	446	2
53	468	249	467	250	463	257	459	265	45	272	45	2
54	477	252	476	255	472	262	468	270	463	278	463	2
55	486	258	485	259	481	267	476	275	472	283	471	2
56	494	263	494	264	490	271	485	280	480	288	480	2
57	503	268	503	269	498	276	494	285	489	293	489	.
58	512	272	512	273	507	281	502	290	497	298	497	2
59	521	277	520	278	516	286	511	295	506	303	506	:
60	530	282	529	283	525	291	520	300	515	308	514	.
61	53,9	28,6	53.8	28,7	53.3	29,6	52.8	30 5	52,3	31,4	52,3	
62	547	291	547	292	542	301	537	310	532	319	532	
63	556	296	556	297	551	305	546	315	540	324	540	
64	565	300	564	302	560	310	554	320	549	329	5 9	
65	574	305	573	305	568	315	563	325	557	334	557	
66	583	310	582	311	577	320	572	330	566	339	566	
67	592	314	591	316	586	325	580	335	575	343	574	
68	600	319	600	320	595	330	589	340	583	350	583	
69	609	324	608	325	603	334	597	345	592	355	592	
70	618	329	617	330	612	339	606	350	600	360	600	
71	62,7	33.3	62,6	33,5	62,1	34,4	61,5	35,5	60,9	36.5	60,9	
72	636	338	635	339	630	349	623	360	618	370	617	
73	644	343	644	344	638	354	632	365	626	375	626	
74	653	347	653	349	647	359	641	370	635	380	634	
75	662	352	661	354	656	364	649	375	643	386	643	
76	671	357	670	358	665	368	658	380	652	391	651	
77	680	361	679	363	673	373	667	385	660	396	660	
78	689	366	688	368	682	378	675	390	669	401	669	
79	697	371	697	373	691	383	685	395	678	406	677	
80	706	376	705	377	700	388	693	00	686	41.	686	
D	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
	62 Deg.		5 P. 1 h.		61 Deg.		60 Deg.		5 P. 9		59 D	

Dist.	28 Deg.		2 P. 1 h.		29 Deg.		30 Deg.		2 Pt, 39.		31 Deg.		Dist.
	Lat,	dep'	Lat,	dep.	Lat	dep.	Lat,	dep'	Lat,	dep	Lat	dep,	
81	71.5	38,0	71.4	38,2	70,6	39.3	70,1	40.5	69,5	41.6	69,4	41,7	81
82	72 4	38 5	72 3	38 6	71 7	39 7	709	41 0	70 3	42 2	70 3	42 2	82
83	73 3	39 0	73 2	39 1	72 6	40 2	71 9	41 5	71 2	42 7	71 1	42 7	83
84	74 2	39 4	74 1	39 6	73 5	40 7	72 8	42 0	72 1	43 2	72 0	43 3	84
85	75 0	39 9	75 0	40 1	74 3	41 2	73 7	42 5	72 9	43 7	72 9	43 8	85
86	75 9	40 4	75 8	40 5	75 2	41 7	74 5	43 0	73 8	44 2	73 7	44 3	86
87	76 8	40 8	76 7	41 0	76 1	42 2	75 3	43 5	74 6	44 7	74 6	44 8	87
88	77 7	41 3	77 6	41 5	77 0	42 7	76 2	44 0	75 5	45 2	75 4	45 3	88
89	78 6	41 8	78 5	41 9	77 8	43 1	77 1	44 5	76 3	45 8	76 3	45 8	89
90	79 5	42 3	79 4	42 4	78 7	43 6	77 9	45 0	77 2	46 3	77 2	46 3	90
91	80,4	42.7	80.2	42.9	79,6	44.1	78.8	45,5	78.1	46,8	78,1	46.9	91
92	81 2	43 2	81 1	43 4	80 5	44 6	797	46 0	78 9	47 3	78 9	47 4	92
93	82 1	43 6	82 0	43 8	81 3	45 1	80 5	46 5	79 8	47 8	79 7	47 9	93
94	83 0	44 1	82 9	44 3	82 2	45 6	81 4	47 0	80 6	48 3	80 6	48 4	94
95	83 9	44 6	83 8	44 8	83 1	46 1	82 3	47 5	81 5	48 8	81 4	48 9	95
96	84 8	45 1	84 7	45 2	84 0	46 5	83 1	48 5	82 3	49 3	82 3	49 4	96
97	85 6	45 5	85 5	45 7	84 8	47 0	84 0	48 0	83 2	49 9	83 1	50 0	97
98	86 5	46 0	86 4	46 2	85 7	47 5	84 9	49 5	84 1	50 4	84 0	50 5	98
99	87 4	46 6	87 3	46 7	86 6	48 0	85 7	49 0	84 9	50 9	84 9	51 0	99
100	88 3	46 9	88 2	47 1	87 5	48 5	866	50 0	85 8	51 4	85 7	51 5	100
101	89,2	47.4	89.1	47.6	88.3	49,0	87,5	50.5	86.6	51.9	86,6	52.0	101
102	90 1	47 9	90 0	48 1	89 2	49 4	88 3	51 0	87 5	52 4	87 4	52 5	102
103	91 0	48 4	90 8	48 5	90 1	49 9	89 2	51 5	88 3	52 9	88 3	53 0	103
104	91 9	48 8	91 7	49 0	91 0	50 4	90 1	52 0	89 2	53 4	89 1	53 6	104
105	92 8	49 3	92 6	49 5	91 8	50 9	90 9	52 5	90 1	54 3	90 0	54 1	105
106	93 6	49 8	93 5	49 9	92 7	51 4	91 8	53 0	90 9	54 5	90 8	54 6	106
107	94 5	50 2	94 4	50 4	93 6	51 9	92 7	53 5	91 8	55 0	91 7	55 1	107
108	95 4	50 7	95 3	50 9	94 5	52 4	93 5	54 0	92 6	55 5	92 6	55 6	108
109	96 2	51 2	96 1	51 4	95 3	52 8	94 4	54 5	93 5	56 0	93 4	56 1	109
110	97 1	51 6	97 0	51 8	96 2	53 3	95 3	55 0	94 3	56 5	94 3	56 7	110
111	98,0	52.1	97,9	52,3	97,1	53,8	96,1	55.5	95.2	57.0	95.1	57,2	111
112	98 9	52 6	98 8	52 8	98 0	54 3	97 0	56 0	96 1	57 6	96 0	57 7	112
113	99 8	53 1	99 7	53 2	98 8	54 8	97 9	56 5	96 9	58 1	96 8	58 2	113
114	100 7	53 5	100 5	53 7	99 7	55 3	98 7	57 0	97 8	58 6	97 7	58 7	114
115	101 5	54 0	101 4	54 2	100 6	55 8	99 6	57 5	98 6	59 1	98 6	59 2	115
116	102 4	54 5	102 3	54 7	101 5	56 2	100 5	58 0	99 5	59 6	99 4	59 7	116
117	103 3	54 9	103 2	55 1	102 3	56 7	101 3	58 5	100 4	60 1	100 3	60 3	117
118	104 2	55 4	104 1	55 6	103 2	57 2	102 2	59 0	101 2	60 6	101 1	60 8	118
119	105 1	55 9	105 0	56 1	104 1	57 7	103 1	59 5	102 1	61 2	102 0	61 3	119
120	106 0	56 1	105 8	56 1	105 0	58 2	103 9	60 0	102 9	61 7	102 3	61 8	120
Dist.	dep,	Lat,	dep.	Lat,	dep,	Lat,	dep.	Lat,	dep.	Lat.	dep,	Lat,	Dist.
	62 Deg,		5 P. 1 h,		61 deg,		60 Deg.		5 Pt, 1 q,		69 Deg,		

Diff.	28 deg.		, 2 P. 1 h		29 Deg,		30 deg.		2 Pts. 39,		31 deg,		Dif.
	Lat.	dep	Lat,	dep,	Lat,	dep,	Lat.	dep'	Lat,	dep	Lat,	dep.	
121	06,8	56,8	106.7	57 0	105,8	58.7	104 8	60.5	103.8	62,2	103,7	62,2	.21
122	107 7	57 3	107 6	57 5	106 7	59 1	105 7	61 0	104 6	62 7	104 6	62 8	122
123	108 6	57 7	108 5	58 0	107 6	59 6	106 5	61 5	105 5	63 2	105 4	63 3	123
124	109 5	58 2	109 4	58 5	108 5	60 1	107 4	62 0	106 4	63 7	106 3	63 9	124
125	110 4	58 7	10 3	58 9	109 3	60 6	108 3	62 5	107 2	64 2	107 1	64 4	125
126	111 3	59 2	111 1	59 4	110 2	61 1	109 1	63 0	108 1	64 8	108 0	64 9	126
127	112 2	59 6	112 0	59 8	111 1	61 6	110 0	63 5	109 0	65 3	108 8	65 4	127
128	113 0	60 1	1129	60 3	111 9	62 1	110 8	64 0	109 8	65 8	109 7	65 9	128
12	113 9	60 6	113 8	60 8	1128	62 5	111 7	64 5	110 6	66 3	110 6	66 4	129
130	114 8	61 0	1147	61 3	1137	63 0	112 6	65 0	111 5	66 8	111 4	67 0	130
131	115,7	61,5	115,5	61,7	114,6	63.5	113.4	65.5	112,4	67,3	112.3	67,5	131
132	116 6	62 9	116 4	62 2	115 4	64 0	114 3	66 0	113 2	67 8	113 1	68 0	132
133	117 5	62 4	117 3	62 7	116 3	64 5	115 2	66 5	114 1	68 4	114 0	68 5	133
134	118 3	62 9	118 2	63 1	117 2	65 0	116 0	67 0	114 9	68 9	114 8	69 0	134
135	119 2	63 4	119 1	63 6	118 1	65 4	116 9	67 5	115 8	69 4	115 7	69 5	135
136	120 1	63 9	120 0	64 1	118 9	65 9	117 8	68 0	116 6	69 9	116 6	70 0	136
137	121 0	64 3	120 8	64 5	119 8	66 4	118 6	68 5	117 5	70 4	117 4	70 6	137
138	121 9	64 8	121 7	65 0	120 7	66 9	119 5	69 0	118 4	70 9	118 3	71 1	138
139	122 7	65 3	122 6	65 5	121 6	67 4	120 4	69 5	119 2	71 4	119 1	31 6	139
140	123 6	65 7	123 5	66 0	122 4	67 9	121 2	70 0	120 1	72 0	120 0	21	140
141	124,5	66,2	124.4	66,4	123.3	68.4	122.1	70,5	120,9	72,5	120,8	72,6	141
142	125 4	66 7	125 2	66 9	124 2	68 8	123 0	71 0	121 8	73 0	121 7	73 1	142
143	126 3	67 1	126 1	67 4	125 1	69 3	123 8	71 5	122 7	73 5	122 6	73 6	143
144	127 2	67 6	127 0	67 8	125 9	69 8	124 7	720	123 5	74 0	123 4	74 2	144
145	128 0	68 1	127 9	68 3	126 8	70 3	125 6	725	124 4	74 6	124 3	74 7	145
146	128 9	68 5	128 8	68 8	127 7	70 8	126 4	73 0	125 2	75 0	125 1	75 2	146
147	129 8	69 0	129 7	69 3	128 6	71 3	127 3	73 5	126 1	75 6	126 0	75 7	147
148	130 7	69 5	130 5	69 7	129 4	71 8	128 2	74 0	126 9	76 1	126 8	76 2	148
149	131 6	70 0	131 4	70 2	130 3	72 2	129 0	74 5	127 8	76 6	127 7	76 7	149
150	132 5	704	132 3	70 7	131 2	72 7	129 9	75 0	128 7	77 1	128 6	77 3	150
151	133,	70,9	133,2	71.1	132,1	73,2	130.8	75,5	129,5	77,6	129,4	77,8	151
152	134 2	71 4	134 1	71 6	132 9	73 7	131 6	76 0	130 4	78 1	130 3	78 3	152
153	135 1	71 8	134 9	72 1	133 8	74 2	132 5	76 5	131 2	78 6	131 1	78 8	153
154	136 0	72 3	135 8	72 6	134 7	74 7	133 4	77 0	132 1	79 1	132 0	79 3	154
155	136 9	72 8	136 7	73 0	135 6	75 1	134 2	77 5	132 9	79 7	132 8	79 8	155
156	137 7	73 2	137 6	73 5	136 4	75 6	135 1	78 0	133 8	80 2	133 7	80 3	156
157	138 6	73 8	138 5	74 0	137 3	76 1	136 0	78 5	134 7	80 7	134 5	80 9	157
158	139 5	74 2	139 4	74 4	138 2	76 6	136 8	79 0	135 5	81 2	135 4	81 4	158
159	140 4	74 6	140 2	74 9	139 1	77 1	137 7	79 5	136 4	81 7	136 3	81 9	159
160	141 3	75 1	141 9	75 4	139 9	77 6	138 6	80 0	137 2	82 2	137 1	82 4	160
Dif.	dep,	Lat.	dep.	Lat,	dep,	Lat.	dep.	Lat.	dep,	Lat.	dep,	Lat,	Dif.
	62 Deg,		5 Pt. 1 h,		61 Deg,		60 Deg.		5 P. 1 q,		59 deg,		

Diff	32 deg.		33 Deg.		2 Points		34 Deg.		35 Deg.		36 Deg.		Diff
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
1	00,8	00,5	00,8	00 5	00,8	00,6	00,8	00,5	00,8	00,6	00,8	00,6	
2	01 7	01 1	01 7	01 1	01,7	01 1	01 6	01 1	01 6	01 1	01 6	01 2	
3	02 5	01 6	02 5	01,6	02 5	01 7	02 5	01 7	02 5	01,7	02 4	01 8	
4	03 4	02 1	03 4	02 2	03 3	02,2	03 3	02,2	03 3	02 3	03 2	02 4	
5	04 2	02 6	04 2	02 7	04 2	02 8	04 1	02,8	04,1	02 9	04 c	02 9	
6	05 1	03,2	05,0	03 3	05,0	03,3	05,0	03 2	04,9	03,4	04 9	03 5	
7	05 9	03,7	05 9	03 8	05 8	03,9	05 8	03,9	05 7	04 0	05 7	04,1	
8	06,8	04 2	06 7	04,4	06.6	04,4	06,6	04,5	06 6	04 6	06,5	04,7	
9	07 6	04 8	07 5	04 9	07 5	05 0	07 5	05 0	07 4	05 2	07 3	05,3	
10	08 5	05,3	08 4	05 4	08 3	05,6	08 3	05 6	08 2	05 7	08 1	05 9	
11	09 3	05 8	09 2	06 0	09 1	06,1	09 1	06 2	09 0	06 3	08 9	06,5	
12	10,2	06 4	10 1	06 5	10,0	06 7	09 9	06 7	09 8	06,9	09 7	07 0	
13	11 0	06 9	10 9	07,1	10 8	07,2	10 8	07 3	10 6	07,5	10 5	07 6	
14	11 9	07 4	11,7	07 6	11,6	07,8	11,6	07 8	11,5	08,0	11,3	08,2	
15	12 7	07 9	12 6	08,2	12 5	08 3	12 4	08 3	12 3	08,6	12 1	08 8	
16	13 6	08 5	13 4	08 7	13 3	08,9	13 3	08 9	13 1	09,2	12 9	09,4	
17	14 4	09,0	14 3	09 3	14 1	09 4	14 1	09,5	13 9	09,8	13 8	10 0	
18	15 3	09,5	15,1	09 8	15 0	10,0	14 9	10 1	14 7	10 3	14 6	10 6	
19	16,1	10,1	15 9	10,3	15 8	10 6	15 8	10 6	15,6	10,9	15,4	11 2	
20	17 0	10,6	16 8	10,9	16,6	11,1	16.6	11,2	16 4	11,5	16 2	11.8	
21	17 8	11,1	17 6	11 4	17 5	11 7	17 4	11 7	17 2	12,0	17 0	12 3	
22	18 7	11,7	18 5	12,0	18 3	12 2	18 2	12 3	18 0	12 6	17,8	12 9	
23	19 5	12,2	19 3	12 5	19,1	12 8	19 1	12 9	18 8	13,2	18 6	13 5	
24	20 4	12 7	20 1	13 1	20 0	13 3	19,9	13 4	19 7	13.8	19 4	14 1	
25	21,2	13 2	21,0	13 6	20,8	13 9	20 7	14 0	20,5	14,3	20 2	14 7	
26	22 0	13,8	21,8	14 2	21 6	14 4	21,6	14,5	21 3	14 9	21 0	15 3	
27	22 9	14 3	22 6	14 7	22,4	15,0	22 4	15 1	22 1	15,5	21 8	15 9	
28	23 7	14 8	23 5	15 2	23,3	15 6	23 2	15 7	22 9	16 1	22 7	16 5	
29	24 6	15,4	24 3	15 8	24,1	16 1	24 0	16,2	23 8	16,6	23 5	17 0	
30	25 4	15,9	25 2	16 3	24 9	16,7	24 9	16,8	24 6	17 2	24 3	17 6	
31	26,3	16 4	26 0	16 9	25,8	17,2	25 7	17 3	25,4	17 8	25,1	18,2	
32	27 1	17,0	26,8	17 4	26,6	17 8	26 5	17 9	26 2	18,4	25,9	18,8	
33	28 0	17,5	27 7	17 0	27,4	18,3	27 4	18 5	27 0	18 9	26 7	19,4	
34	28 8	18 0	28 5	18 5	28,3	18,9	28 2	19,0	27 9	19 5	27 5	20 0	
35	29 7	18 5	29 4	18 1	29,1	19 4	29 0	19 6	28 7	20 1	28 3	20 6	
36	30,5	19 1	30 2	19,6	29,9	20,0	29 8	20 1	29 5	20,6	29 1	21 2	
37	31,4	19 6	31 0	19,1	30,8	20 6	30,7	20 7	30,3	21,2	29,9	21,7	
38	32 2	20 1	31,9	20,7	31,6	21 1	31 5	21 2	31 1	21 8	30 7	22 3	
39	33 1	20 7	32 7	20 2	32.4	21 7	32 3	21 8	32 0	22 4	31 6	22 9	
40	33 9	21 2	33 6	21 8	33,3	22,2	33 2	22 4	32 8	22,9	32 4	23 5	
Diff	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Diff
	58 deg.		57 Deg.		5 Points		56 Deg.		55 Deg.		54 Deg.		

Dist.	32 Deg. Lat.	dep.	33 deg. Lat.	dep.	3 Points Lat.	dep.	34 Deg. Lat.	dep.	35 Deg. Lat.	dep.	36 Deg. Lat.	dep.	Dist.
41	34,8	21,7	34,4	22.3	34.1	22,8	34,0	22,9	33,6	23.5	33.2	24.1	41
42	35 6	22 3	35 2	22 9	34 9	23 3	34 8	23 5	34 4	24 1	34 0	24 7	42
43	36 5	22 8	36 1	23 4	35 7	23 9	35 6	24 0	35 2	24 6	34 8	25 3	43
44	37 4	23 3	36 9	24 0	36 6	24 4	36 5	24 9	36 0	25 2	35 6	25 9	44
45	38 3	23 8	37 7	24 5	37 4	25 0	37 2	25 2	36 9	25 8	36 4	26 4	45
46	39 0	24 4	38 0	25 0	38 2	25 5	38 1	25 7	37 7	26 4	37 2	27 0	46
47	39 9	24 9	39 4	25 6	39 1	26 1	39 0	26 3	38 5	26 9	38 0	27 6	47
48	40 7	25 4	40 3	26 1	39 9	26 7	39 8	26 8	39 3	27 5	38 8	28 1	48
49	41 5	26 0	41 1	26 7	40 7	27 2	40 6	27 4	40 1	28 1	39 6	28 8	49
50	42 4	26 5	41 9	27 2	41 6	27 8	41 4	28 0	41 0	28 7	40 4	29 4	50
51	43,2	27,0	42.5	27,8	42,4	28,3	42,3	28.5	41,8	29,2	41,3	30.0	51
52	44 1	27 6	43 6	28 3	43 2	28 9	43 1	29 1	42 6	29 8	42 1	30 6	52
53	44 9	28 1	44 5	28 9	44 1	29 4	43 9	29 6	43 4	30 4	42 9	31 2	53
54	45 8	28 6	45 3	29 4	44 9	30 0	44 8	30 2	44 2	31 0	43 7	31 7	54
55	46 6	29 1	46 1	30 0	45 7	30 6	45 6	30 7	45 1	31 5	44 5	32 3	55
56	47 5	29 7	47 0	30 5	46 6	31 1	46 4	31 3	45 9	32 1	45 3	32 9	56
57	48 3	30 2	47 8	31 0	47 4	31 7	47 3	31 9	46 7	32 7	46 1	33 5	57
58	49 2	30 7	48 7	31 6	48 2	32 2	48 1	32 4	47 5	33 3	46 9	34 1	58
59	50 0	31 3	49 5	32 1	48 9	32 8	48 9	33 0	48 3	33 8	47 7	34 7	59
60	50 9	31 8	50 3	32 7	49 9	33 3	49 7	33 5	49 1	34 4	48 5	35 3	60
61	51,7	32,3	51.2	33,2	50,7	33,9	50,6	34.1	50,0	34,9	49,3	35.9	61
62	52 6	32 9	52 0	33 8	51 5	34 4	51 4	34 7	50 8	35 6	50 2	36 4	62
63	53 4	33 4	52 9	34 3	52 4	35 0	52 2	35 2	51 6	36 1	51 0	37 0	63
64	54 3	33 9	53 7	34 9	53 2	35 5	53 1	35 8	52 4	36 7	51 8	37 6	64
65	55 1	34 4	54 5	35 4	54 0	36 1	53 9	36 3	53 2	37 3	52 7	38 2	65
66	56 0	35 0	55 5	35 9	54 9	36 7	54 7	36 9	54 1	37 9	53 4	38 8	66
67	56 8	35 5	56 2	36 5	55 7	37 2	55 5	37 5	54 9	38 4	54 2	39 4	67
68	57 7	36 0	57 0	37 0	56 5	37 8	56 4	38 0	55 7	39 0	55 0	40 0	68
69	58 5	36 6	57 9	37 6	57 4	38 3	57 2	38 6	56 5	39 6	55 8	40 6	69
70	59 4	37 1	58 7	38 1	58 2	38 9	58 0	39 1	57 3	40 1	56 6	41 1	70
71	60.2	37.6	59,6	38,7	59,0	39.4	58,9	39,7	58,2	40,7	57,4	41,7	71
72	61 0	38 1	60 4	39 2	59 8	40 0	59 7	40 3	59 0	41 3	58 2	42 3	72
73	61 9	38 7	61 2	39 8	60 7	40 6	60 5	40 8	59 8	41 9	59 1	42 9	73
74	62 7	39 2	62 1	40 3	61 5	41 1	61 3	41 4	60 6	42 4	59 9	43 0	74
75	63 6	39 7	62 9	40 8	62 4	41 7	62 2	41 9	61 4	43 0	60 0	44 1	75
76	64 4	40 3	63 8	41 5	63 2	42 2	63 0	42 5	62 3	43 6	61 5	44 7	76
77	65 3	40 8	64 6	41 9	64 0	42 8	63 8	43 0	63 1	44 2	62 3	45 3	77
78	66 1	41 3	65 4	42 5	64 8	43 3	64 7	43 6	63 9	44 7	63 1	45 8	78
79	67 0	41 9	66 3	43 0	65 7	43 9	65 5	44 2	64 7	45 3	63 9	46 4	79
80	67 8	42 4	67 1	43 6	66 6	44 4	66 3	44 7	65 5	45 9	64 7	47 0	80
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	58 Deg.		57 Deg.		5 Points		50 Deg.		55 Deg.		54 Deg.		

Dist.	32 Deg.		33 Deg.		3 Points		34 Deg.		35 Deg.		36 Deg.		Dist.
	Lat,	dep'	Lat,	dep.	Lat.	dep.	Lat,	dep.	Lat,	dep.	Lat.	dep,	
81	68.7	42.9	68.0	44.1	67,3	45.0	67,1	45.3	66.4	46.5	65,5	47.6	81
82	69 5	43 4	68 8	44 7	68 2	45 5	68 0	45 8	67 2	47 0	66 3	48 2	82
83	70 4	44 0	69 6	45 2	69 0	46 0	68 8	46 4	68 0	47 6	67 1	48 8	83
84	71 2	44 5	70 5	45 8	69 8	46 7	69 6	47 0	68 8	48 2	68 0	49 4	84
85	72 1	45 0	71 3	46 3	70 7	47 2	70 5	47 5	69 6	48 8	68 8	50 0	85
86	72 9	45 6	72 1	46 8	71 5	47 8	71 3	48 1	70 5	49 3	69 6	50 5	86
87	73 8	46 1	73 0	47 3	72 3	48 3	72 1	48 6	71 3	49 9	70 4	51 1	87
88	74 6	46 6	73 8	47 9	73 2	48 9	72 9	49 2	72 1	50 5	71 2	51 7	88
89	75 5	47 2	74 7	48 5	74 0	49 4	73 8	49 8	72 9	51 0	72 0	52 3	89
90	76 3	47 7	75 5	49 0	74 8	50 0	74 6	50 3	73 6	51 6	72 8	52 9	90
91	77,2	48.2	76.3	49,6	75,7	50,0	75.4	50.9	74.5	52.2	73,6	53.5	91
92	78 0	48 7	77 2	50 1	76 5	51 1	76 2	51 4	75 4	52 8	74 4	54 1	92
93	78 9	49 2	78 0	50 6	77 3	51 7	77 1	52 0	76 2	53 3	75 2	54 7	93
94	79 7	49 8	78 9	51 2	78 2	52 2	77 9	52 6	77 0	53 9	76 0	55 2	94
95	80 6	50 3	79 7	51 7	79 0	52 8	78 8	53 1	77 8	54 5	76 9	55 8	95
96	81 4	50 9	80 5	52 3	79 8	53 3	79 6	53 7	78 6	55 1	77 7	56 4	96
97	82 3	51 4	81 4	52 8	80 6	53 9	80 4	54 2	79 5	55 6	78 5	57 0	97
98	83 1	51 9	82 2	53 4	81 5	54 4	81 2	54 8	80 2	56 2	79 3	57 6	98
99	84 0	52 5	83 1	53 9	82 3	55 0	82 1	55 4	81 1	56 8	80 2	58 2	99
100	84 8	53 0	83 9	54 5	83 1	55 6	82 9	55 9	81 9	57 4	80 9	58 8	100
101	85,6	53.5	84,7	55.0	84.0	56.1	83,7	56,6	82.7	57,9	81,7	59.4	101
102	86 4	54 1	85 5	55 5	84 8	56 7	84 6	57 0	83 5	58 5	82 5	60 0	102
103	87 3	54 6	86 4	56 1	85 6	57 2	85 4	57 6	84 4	59 1	83 3	60 5	103
104	88 2	55 1	87 2	56 6	86 5	57 8	86 2	58 2	85 2	59 6	84 1	61 1	104
105	89 0	55 7	88 1	57 2	87 3	58 3	87 0	58 7	86 0	60 2	84 9	61 7	105
106	89 9	56 2	88 9	57 7	88 1	58 9	87 9	59 3	86 8	60 8	85 8	62 3	106
107	90 7	56 7	89 7	58 3	89 0	59 4	88 7	59 8	87 6	61 4	86 6	62 9	107
108	91 6	57 2	90 6	58 8	89 8	60 0	89 5	60 4	88 5	61 9	87 4	63 5	108
109	92 4	57 8	91 4	59 4	90 6	60 5	90 4	61 0	89 3	62 5	88 2	64 1	109
110	93 2	58 3	92 2	59 9	91.4	61 1	91 2	61 5	90 1	63 1	89 0	64 7	110
111	94,1	58.8	93,1	60.5	92,3	61,7	92,0	62.1	90.9	63.7	89.8	65.2	111
112	95 0	59 4	93 9	61 0	93 1	62 2	92 8	62 6	91 7	64 2	90 6	65 8	112
113	95 8	59 9	94 8	61 5	93 9	62 8	93 7	63 2	92 5	64 8	91 4	66 4	113
114	96 7	60 4	95 6	62 1	94 8	63 3	94 5	63 7	93 4	65 4	92 2	67 0	114
115	97 5	61 0	96 4	62 6	95 6	63 9	95 3	64 3	94 2	66 0	93 0	67 6	115
116	98 4	61 5	97 3	63 2	96 4	64 4	96 2	64 9	95 0	66 5	93 8	68 2	116
117	99 2	62 0	98 1	63 7	97 3	65 0	97 0	65 4	95 8	67 1	94 7	68 8	117
118	100 1	62 5	99 0	64 3	98 1	65 5	97 8	66 0	96 6	67 7	95 6	69 4	118
119	100 9	63 1	99 8	64 8	98 9	66 1	98 7	66 5	97 5	68 2	96 3	69 9	119
120	101 8	63 6	100 6	65 4	99 8	66 7	99 5	67 2	98 3	68 8	97 1	70 5	120
Dist.	dep,	Lat,	dep.	Lat.	dep,	Lat.	dep.	Lat,	dep.	Lat.	dep.	Lat.	Dist.
	58 Deg,		57 deg,		5 Points		56 Deg.		55 Deg.		54 Deg.		

Dist.	32 deg		33 Deg,		3 Points		34 Deg,		35 deg,		36 Deg.		Dist.
	Lat.	dep,	Lat,	dep,	Lat,	dep,	Lat,	dep,	Lat,	dep,	Lat,	dep,	
121	102,6	64,1	101.5	65.9	100,6	67,2	100.3	67,7	99.1	69.4	97,9	71.1	121
122	103 5	64 7	102 3	66 4	101 4	67 8	101 1	68 2	99 9	70 0	98 7	71 7	122
123	104 3	65 2	103 1	67 0	102 3	68 3	102 0	68 8	100 7	70 4	99 5	72 3	123
124	105 2	65 7	104 0	67 5	103 1	68 9	102 8	69 3	101 6	71 1	100 3	72 9	124
125	106 0	66 3	104 8	68 1	104 0	69 0	103 6	69 9	102 4	71 7	101 1	73 5	125
126	106 8	66 8	105 7	68 6	104 8	70 8	104 5	70 5	103 2	72 3	101 9	74 1	126
127	107 7	67 3	106 5	69 2	105 6	70 5	105 3	71 0	104 0	72 8	102 7	74 7	127
128	108 5	67 8	107 3	69 7	106 4	71 1	106 1	71 6	104 8	73 4	103 6	75 2	128
129	109 4	68 4	108 2	70 3	107 2	71 7	106 9	72 1	105 6	74 0	104 4	75 8	125
130	110 2	68 9	109 0	70 8	108 1	72 2	107 8	72 7	106 5	74 6	105 2	76 4	130
131	111,1	69,4	119,9	71,3	108,9	72.8	108.6	73,3	107,3	75,1	106.0	77,0	131
132	111 9	70 0	110 7	71 9	119 7	73 3	109 4	73 8	108 1	75 7	106 8	77 6	132
133	112 8	70 5	111 5	72 4	110 6	73 9	110 3	74 4	108 9	76 3	107 6	78 2	133
134	113 6	71 0	112 4	73 0	111 4	74 4	111 1	74 9	109 7	76 8	108 4	78 8	134
135	114 5	71 6	113 2	73 5	112 2	75 0	111 9	75 5	110 6	77 4	109 2	79 4	135
136	115 3	72 1	114 0	74 1	113 1	75 5	112 7	76 1	111 4	78 0	110 0	79 9	136
137	116 2	72 6	114 9	74 6	113 9	76 1	113 6	76 6	112 2	78 6	110 8	80 5	137
138	117 0	73 1	115 7	75 2	114 7	76 7	114 4	77 2	113 0	79 1	111 6	81 1	138
139	117 9	73 7	116 6	75 7	115 6	77 2	115 2	77 7	113 8	79 7	112 5	81 7	139
140	118 7	74 2	117 4	76 2	116 4	77 8	116 1	78 2	114 6	80 3	113 3	82 3	140
141	119,6	74,7	118.2	76,9	117.2	78.3	116.9	78.8	115,5	80,9	114,1	83,9	141
142	120 4	75 3	119 1	77 3	118 1	78 9	117 7	79 4	116 3	81 4	114 9	83 5	142
143	121 3	75 8	119 9	77 9	118 9	79 4	118 5	80 0	117 1	82 0	115 7	84 1	143
144	122 1	76 3	120 8	78 4	119 7	80 0	119 4	80 5	117 9	82 6	116 5	84 6	144
145	123 0	76 9	121 6	79 0	120 5	80 5	120 2	81 1	118 8	83 2	117 3	85 2	145
146	123 8	77 4	122 4	79 5	121 4	81 1	121 0	81 6	119 6	83 7	118 1	85 8	146
147	124 7	77 9	123 3	80 1	122 2	81 7	121 9	82 2	120 4	84 2	118 9	86 4	147
148	125 5	78 4	124 1	80 6	123 0	82 2	122 7	82 8	121 3	84 9	119 7	87 0	148
149	126 4	79 0	125 0	81 1	123 9	82 8	123 5	83 3	122 0	85 3	120 5	87 6	149
150	127 2	79 5	125 8	81 7	124 7	83 3	124 4	83 9	122 8	86 0	121 3	88 2	150
151	128,0	80,0	126,6	82,2	125,5	83.9	125.2	84.4	123,7	86,6	122,2	88,9	151
152	128 9	80 6	127 5	82 8	126 4	84 4	126 0	85 0	124 5	87 2	123 0	89 3	152
153	129 7	81 1	128 8	83 3	127 2	85 0	126 8	85 6	125 3	87 7	123 8	89 9	153
154	130 6	81 6	129 3	83 9	128 0	85 5	127 7	86 1	126 1	88 3	124 6	90 5	154
155	131 4	82 2	130 0	84 4	128 9	86 1	128 5	86 7	126 9	88 9	125 4	91 1	155
156	132 3	82 7	130 8	85 0	129 7	86 7	129 3	87 2	127 8	89 5	126 2	91 7	156
157	133 1	83 2	131 7	85 3	130 5	87 2	130 2	87 8	128 6	90 0	127 0	92 3	157
158	134 0	83 7	132 5	86 8	131 4	87 8	131 0	88 4	129 4	90 6	127 8	92 9	158
159	134 8	84 3	133 3	86 6	132 2	88 2	131 8	88 9	130 2	91 2	128 6	93 5	159
160	135 7	84 8	134 2	87 1	133 0	89 9	132 6	89 3	131 0	91 8	129 4	94 0	160
Dist.	dep,	Lat	dep.	Lat,	dep,	Lat.	dep.	Lat	dep,	Lat.	dep,	Lat,	Dist.
	58 Deg,		57 deg.		5 Points.		56 Deg.		55 Deg.		54 deg.		

Dif.	3 P, 1 q, Lat.	dep.	37 Deg. Lat.	dep.	38 deg, Lat.	dep.	39 Deg. Lat.	dep.	3 P. 1 h. Lat.	dep.	40 Deg. Lat.	dep.
1	00,8	00,6	00,8	00 6	00,8	00,6	00,8	00,7	00,8	00,6	00,8	00,6
2	01 6	01 2	01 6	01 2	01,6	01 2	01 5	01 3	01 5	01 3	01 5	01 3
3	02 4	01 8	02 4	01,8	02 5	01 8	02 3	01 9	02 3	01,9	02 3	01 9
4	03 2	02 4	03 2	02 4	03 1	02,5	03 5	02,5	03 1	02 5	03 1	02 6
5	04 0	03,0	04 0	03 0	03,9	03 1	03 9	03 1	03,9	03 2	03 8	03 2
6	04 8	03,6	04,8	03 6	04 7	03,7	04 6	03,9	04,6	03,8	04 6	03 9
7	05 6	04 2	05 6	04,2	05 5	04,3	05 4	04,4	05 4	04 4	05 4	04,5
8	06,4	04 8	06 4	04 8	06.3	04,9	06,2	05 0	06.3	05 1	06,1	05 1
9	07 2	05,4	07 2	05 4	07 1	05 5	07 0	05 7	07 0	05 7	06 9	05,8
10	08 0	06 0	08 0	06 0	07 9	06,2	07 8	06 3	07 7	06 3	07 7	06 4
11	08,8	06 6	08 8	06 6	08 7	06,8	08 5	06 9	08 5	07,0	08 4	07 1
12	09 6	07 1	09 6	07,2	09 4	07 4	09 3	07 5	09 3	07,6	09 2	07 7
13	10,4	07 7	10 4	07 8	10,2	08,0	10 1	08 2	10 0	08,2	10 0	08,4
14	11 2	08 4	11,2	08,4	11 0	08,6	10 9	08 8	10 8	08,8	10 7	09 0
15	12 0	08,9	12 0	09 0	11,8	09 2	11,6	09,4	11,6	09,5	11,5	09,6
16	12 8	09,5	12 8	09 6	12 6	09,8	12 4	10 1	12 4	10 1	12 3	10 3
17	13 6	10,1	13 6	10,2	13 4	10 5	13 2	10 7	13 1	10,8	13 0	10 9
18	14 5	10,7	14 4	10,8	14 2	11,1	13 9	11,3	13 9	11,4	13 8	11.6
19	15 3	11,3	15.2	11 4	15 0	11 7	14 8	12 0	14 7	12,0	14 5	12 2
20	16,1	11,9	16 0	12,0	15 8	12,2	15 5	12 6	15,5	12 7	15.3	12 9
21	16 9	12,5	16 8	12 6	16,5	12 9	16.3	13 2	16 2	13.3	16 1	13 5
22	17 7	13 1	17 6	13 2	17 3	13 5	17 1	13 6	17 0	14,0	16 8	14 1
23	18 5	13,7	18 4	13 8	18,1	14 2	17 9	14,5	17 8	14 6	17,6	14 8
24	19 3	14 3	19 2	14 4	18 9	14 8	18 6	15 1	18 4	15,2	18 4	15 4
25	20 1	14 9	20 0	15 0	19,7	15 4	19,4	15 7	19 0	15 9	19 1	16 1
26	20,9	15,5	20,5	15 6	20 5	16 0	20 2	16,4	20,1	16,5	19 9	16 7
27	21 7	16,1	21,6	16 2	21 3	16,6	21,0	17 0	20 9	17 1	20 7	17 4
28	22 5	16 7	22 4	16 8	22,1	17 2	21 8	17 6	21 6	17 8	21 4	18,0
29	23 3	17,3	23 2	17 4	22,8	17 8	22 1	18 3	22 4	18,4	22 2	18,6
30	24 1	17,9	24 0	18 0	23,6	18,5	23 3	18,9	23 2	19 0	23 0	19,3
31	24 9	18 5	24 5	18 6	24 4	19,1	24 1	19 5	24 0	19,7	23 7	19 9
32	25 7	19 1	25 6	19,3	25,2	19 7	24 9	20 1	24 7	20 3	24 5	20 6
33	26 5	19 7	26 4	19,9	26,0	20,3	25 6	21 8	25,5	20,9	25,3	21 2
34	27,3	20 2	27,1	20,5	26,8	20,6	26 4	21 4	26 3	21,6	26.0	21,9
35	28 1	20 8	27 9	21 1	27,6	21 5	27 2	22 0	27 0	22 2	26 8	22 5
36	28 9	21 4	28 7	21 7	28,4	22,2	27 9	22 7	27 8	22,9	27 6	23 1
37	29 7	22 0	29 5	22 3	29,2	22 8	28 8	23,3	28 6	23 5	28 3	23 8
38	30,5	22 6	30 3	22 9	29,9	23 4	29 5	23,9	29 4	24,1	29 1	24 4
39	31,3	23 2	31 1	23 5	30,7	24 0	30,3	24 5	30,1	24 7	29,9	25 1
40	32 1	23 8	31,9	24 1	31,5	24,6	31 1	25 2	30 9	25 4	30 6	25 7
Dif.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.
	4 P. 3 q.		53 Deg.		52 deg.		51 Deg.		4 P. 1 h.		50 Deg.	

Dist.	3 P. 1 q.		37 Deg.		38 Deg.		39 Deg.		3 Pt. 1 h.		40 Deg.		Dist.
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
41	32,9	24,4	32,7	24,7	32,3	25,2	31,9	25,8	31,7	26,0	31,4	26,4	41
42	33 7	25 0	33 5	25 3	33 1	25 0	32 6	26 4	32 0	26 6	32 2	27 0	42
43	34 5	25 6	34 3	25 9	33 9	26 5	33 4	27 1	33 2	27 3	33 5	27 6	43
44	35 3	26 2	35 1	26 5	34 7	27 1	34 2	27 7	34 0	27 9	33 7	28 3	44
45	36 1	26 8	35 9	27 1	35 8	27 7	35 0	28 3	34 9	28 5	34 5	28 9	45
46	36 9	27 4	36 7	27 7	36 2	28 3	35 7	29 0	35 6	29 2	35 2	29 6	46
47	37 7	28 0	37 5	28 3	37 0	28 9	36 5	29 6	36 3	29 8	36 0	30 2	47
48	38 5	28 6	38 3	28 9	37 8	29 5	37 3	30 2	37 1	30 4	36 8	30 9	48
49	39 3	29 2	39 1	29 5	38 6	30 2	38 1	30 8	37 9	31 1	37 5	31 5	49
50	40 2	29 8	39 9	30 1	39 4	30 8	38 9	31 5	38 6	31 7	38 3	32 1	50
51	41,0	30,4	40.7	30,7	40,2	31,4	39,6	32,1	39,4	32,3	39,1	32.8	51
52	41 8	31 0	41 5	31 3	41 0	32 0	40 4	32 7	40 1	33 0	39 8	33 4	52
53	42 6	31 6	42 3	31 9	41 8	32 6	41 2	33 3	41 0	33 6	40 6	34 1	53
54	43 4	32 2	43 1	32 5	42 5	33 2	42 0	34 0	41 7	34 3	41 4	34 7	54
55	44 1	32 8	43 9	33 1	43 3	33 9	42 7	34 6	42 5	34 9	42 1	35 4	55
56	45 0	33 2	44 7	33 7	44 1	34 5	43 5	35 2	43 3	35 5	42 9	36 0	56
57	45 8	33 9	45 5	34 3	44 9	35 1	44 3	35 9	44 1	36 2	43 7	36 6	57
58	46 6	34 5	40 3	34 9	45 7	35 8	45 1	36 7	44 8	36 8	44 4	37 3	58
59	47 1	35 1	47 1	35 5	46 5	36 3	45 8	37 1	45 6	37 4	45 2	37 9	59
60	48 2	35 7	47 9	36 1	47 3	36 9	46 6	37 5	46 4	38 1	46 0	38 6	60
61	49,0	36,3	48.7	36.7	48,1	37,5	47 4	38,4	47,1	38,7	46,7	39,2	61
62	49 8	36 9	49 5	37 3	48 8	38 2	48 2	39 0	47 9	39 3	47 5	39 9	62
63	50 6	37 5	50 3	37 9	49 6	38 8	49 0	39 6	48 7	40 0	48 3	40 5	63
64	51 4	38 1	51 1	38 5	50 4	39 4	49 7	40 3	49 5	40 6	49 0	41 2	64
65	52 2	38 7	51 9	39 1	51 2	40 0	50 5	40 9	50 2	41 2	49 8	41 8	65
66	53 0	39 3	52 7	39 7	52 0	40 6	51 3	41 5	51 0	41 9	50 5	42 4	66
67	53 8	39 9	53 5	40 3	52 8	41 2	52 1	42 2	51 8	42 5	51 3	43 1	67
68	54 6	40 5	54 3	40 9	53 6	41 9	52 8	42 8	52 6	43 1	52 1	44 7	68
69	55 4	41 1	55 1	41 5	54 4	42 5	53 6	43 4	53 3	43 8	52 9	44 4	69
70	56 2	41 7	55 9	42 1	55 2	43 1	54 4	44 0	54 1	44 4	53 6	45 0	70
71	57,0	42.3	56,7	42,7	55.9	43.7	55,2	44.7	54,9	45,0	54,4	45.6	71
72	57 8	42 9	57 5	43 3	56 7	44 3	55 9	45 3	55 7	45 7	55 1	46 3	72
73	58 6	43 5	58 3	43 9	57 5	44 9	56 7	45 9	56 4	46 3	55 9	46 9	73
74	59 4	44 1	59 1	44 5	58 3	45 6	57 5	46 6	57 2	46 9	56 7	47 6	74
75	60 2	44 7	59 9	45 1	59 2	46 2	58 3	47 2	58 0	47 6	57 4	48 3	75
76	61 0	45 3	60 7	45 7	60 0	46 8	59 1	47 8	58 7	48 2	58 2	48 9	76
77	61 8	45 9	61 5	46 3	60 7	47 4	59 8	48 5	59 5	48 8	59 0	49 5	77
78	62 7	46 5	62 3	46 9	61 5	48 0	60 6	49 1	60 3	49 5	59 7	50 1	78
79	63 5	47 1	63 1	47 5	62 2	48 6	61 4	49 7	61 1	50 1	60 5	50 8	79
80	64 3	47 7	63 9	48 1	63 0	49 3	62 2	50 3	61 8	50 7	61 3	51 4	80
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	4 Pts. 3q.		53 Deg.		52 deg.		51 Deg.		4 P. 1 h.		50 Deg.		

Dist.	3 P. 1 q.		37 Deg.		38 Deg.		39 Deg.		3 P. 1 h.		40 Deg.	
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.
81	63.1	48.3	64.7	48.7	63.8	49.9	62.9	51.0	62.6	51.4	62.2	52.1
82	65 9	48 b	65 5	49 3	64 6	50 5	63 7	51 6	63 4	52 0	62 8	52 7
83	66 7	49 4	66 3	49 9	65 4	51 1	64 5	52 2	64 2	52 6	63 6	53 4
84	67 5	50 c	67 1	50 5	66 2	51 7	65 3	52 9	64 9	53 3	64 3	54 0
85	68 3	50 6	67 9	51 1	67 0	52 3	66 1	53 5	65 7	53 9	65 1	54 6
86	69 1	51 2	68 7	51 7	67 8	52 9	66 8	54 1	66 5	54 6	65 9	55 3
87	69 9	51 8	69 5	52 4	68 6	53 6	67 6	54 8	67 2	55 2	66 6	55 9
88	70 7	52 4	70 3	53 0	96 4	54 2	68 4	55 4	68 0	55 8	67 4	56 6
89	71 5	53 0	71 1	53 6	70 1	55 8	69 2	56 0	68 8	56 5	68 2	57 2
90	72 3	53 6	71 9	54 2	70 9	55.4	69 9	56 6	69 6	57 1	68 9	57 4
91	73,1	54.4	72.7	54,8	71,7	56,0	70 7	57.3	70 0	57,7	69,7	58.5
92	73 9	54 2	73 5	55 4	72 5	56 6	71 5	57 9	71 1	58 4	70 5	59 1
93	74 7	55 8	74 3	56 0	73 3	57 3	72 3	58 5	71 9	59 0	71 3	59 8
94	75 5	56 0	75 1	56 6	74 1	57 9	73 0	59 2	72 7	59 6	72 0	60 4
95	76 3	56 6	75 9	57 2	74 9	58 5	73 8	59 8	73 5	60 3	72 8	61 1
96	77 1	57 2	76 7	57 8	75 0	59 1	74 6	60 4	74 2	60 9	73 6	61 7
97	77 9	57 8	77 5	58 4	76 4	59 7	75 4	61 0	75 0	61 5	74 3	62 4
98	78 7	58 4	78 3	59 0	77 2	60 3	76 2	61 7	75 7	62 2	75 1	63 0
99	79 5	59 0	79 1	59 6	78 0	60 9	76 9	62 3	76 5	62 8	75 8	63 4
100	80 3	59 6	79 9	60 2	78.8	61 6	77 7	62 9	77 3	63 4	76 4	64 1
101	81,1	60,2	80.7	60.8	79,0	62.2	78,5	63.6	78.1	64.0	77,4	64.7
102	81 9	60 8	81 5	61 4	80 4	62 8	79 3	64 2	78 c	64 7	78 1	65 4
103	82 7	61 4	82 3	62 0	81 2	63 4	80 0	64 8	79 6	65 5	78 9	66 2
104	83 5	62 0	83 1	62 6	81 9	64 0	80 8	65 4	80 4	66 0	79 7	66 9
105	84 3	62 6	83 9	63 2	82 7	64 0	81 6	66 1	81 1	66 6	80 4	67 5
106	85 1	63 2	84 7	63 8	83 5	65 3	82 4	66 7	81 9	67 2	81 2	68 1
107	86 c	63 9	85 5	64 4	84 3	65 9	83 1	67 3	82 7	67 9	82 c	68 8
108	86 7	64 3	86 2	65 0	85 1	66 5	83 9	68 0	83 5	68 5	82 7	69 4
109	87 5	64 9	87 0	65 6	85 9	67 1	84 7	68 c	84 2	69 1	83 5	70 1
110	88 2	65.5	87 8	66 2	86 7	67.7	85 5	69 2	85 0	69 8	84 3	70 7
111	89.0	66 1	88,6	66 8	87,5	68,3	86,3	69,9	85.8	70.4	85.0	71,3
112	89 8	66 7	89 4	67 4	88 2	69 0	87 0	70 5	86 6	71 0	85 8	72 0
113	90 6	67 3	90 2	68 0	89 0	69 6	87 8	71 1	87 3	71 7	86 6	72 6
114	91 5	67 9	91 0	68 6	89 8	70 4	88 6	71 7	88 1	72 3	87 3	73 3
115	92 4	68 5	91 8	69 2	90 6	70 2	89 4	72 4	88 9	72 9	88 1	73 9
116	93 2	69 1	92 6	69 8	91 4	71 4	90 1	72 0	89 6	73 6	88 9	74 6
117	94 0	69 7	93 4	70 4	92 2	72 0	90 9	73 6	90 4	74 2	89 6	75 2
118	94 8	70 3	94 2	71 0	93 0	72 7	91 7	74 3	91 2	74 8	90 4	75 9
119	95 6	70 9	95 0	71 6	93 8	73 3	92 5	74 9	92 0	75 5	91 2	76 5
120	96 4	71 5	95 8	72 2	94 5	73 9	93 3	75 5	92 8	76 1	92 0	77 1
	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.
	34 P. 39.		53 deg.		52 Deg.		51 Deg.		4 P. 1 h.		50 Deg.	

Dist.	37 Deg.		38 Deg.		39 Deg.		3 P. 1 h.		40 Deg.		Dist.
	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	
121	97.2	74.1	96.0	74.8	95.3	74.5	94.6	76.1	93.5	76.7	92.7	77.8	121
122	98.0	72.7	97.4	73.4	96.1	75.1	94.8	76.8	94.3	77.4	93.4	78.	122
123	98.8	73.0	98.2	74.0	96.9	75.7	95.6	77.4	95.1	78.0	94.2	79.1	123
124	99.6	73.9	99.0	74.6	97.7	76.3	96.4	78.0	96.8	78.6	95.0	79.7	124
125	100.4	74.6	99.8	75.2	98.5	77.0	97.1	78.7	96.6	79.3	95.7	80.4	125
126	101.2	75.1	100.6	75.8	99.3	77.6	97.9	79.3	97.4	79.9	96.5	81.0	126
127	102.0	75.7	101.4	76.4	100.1	78.2	98.7	79.9	98.1	80.5	97.3	81.6	127
128	102.8	76.3	102.2	77.0	100.9	78.8	99.5	80.6	98.9	81.2	98.0	82.3	128
129	103.6	76.9	103.0	77.6	101.6	79.4	100.2	81.2	99.7	81.8	98.8	82.9	129
130	104.4	77.4	103.8	78.2	102.4	80.0	101.0	81.8	100.5	82.4	99.6	83.6	130
131	105.2	78.0	104.6	78.8	103.2	80.7	101.8	82.4	101.2	83.1	100.3	84.2	131
132	106.0	78.6	105.4	79.4	104.0	81.3	102.6	83.1	102.0	83.8	101.1	84.9	132
133	106.8	79.2	106.2	80.0	104.8	81.9	103.4	83.7	102.8	84.3	101.9	85.5	133
134	107.6	79.8	107.0	80.6	105.6	82.5	104.1	84.3	103.6	85.0	102.6	86.1	134
135	108.4	80.4	107.8	81.2	106.4	83.1	104.9	85.0	104.3	85.6	103.4	86.8	135
136	109.2	81.0	108.6	81.8	107.2	83.7	105.7	85.6	105.1	86.2	104.2	87.4	136
137	110.0	81.6	109.4	82.4	107.9	84.4	106.5	86.2	105.9	86.9	104.9	88.1	137
138	110.8	82.2	110.2	83.0	108.7	85.0	107.2	86.8	106.6	87.5	105.7	88.7	138
139	111.6	82.8	111.0	83.6	109.5	85.6	108.0	87.5	107.4	88.1	106.5	89.4	139
140	112.4	83.4	111.8	84.2	110.3	86.2	108.8	88.1	108.2	88.8	107.2	90.0	140
141	113.2	84.0	112.6	84.9	111.1	86.9	109.6	88.7	109.0	89.4	108.0	90.6	141
142	114.0	84.6	113.4	85.5	111.9	87.4	110.4	89.4	109.7	90.0	108.8	91.3	142
143	114.8	85.2	114.2	86.1	112.7	88.0	111.1	90.0	110.5	90.7	109.5	91.9	143
144	115.6	85.8	115.0	86.7	113.5	88.7	111.9	90.6	111.3	91.3	110.3	92.6	144
145	116.4	86.4	115.8	87.3	114.2	89.3	112.7	91.2	112.1	92.0	111.1	93.2	145
146	117.2	87.0	116.6	87.9	115.0	89.8	113.5	91.9	112.8	92.6	111.8	93.9	146
147	118.0	87.6	117.4	88.5	115.8	90.5	114.2	92.5	113.6	93.2	112.6	94.5	147
148	118.8	88.2	118.2	89.1	116.6	91.1	115.0	93.1	114.4	93.9	113.4	95.1	148
149	119.7	88.8	119.0	89.7	117.4	91.7	115.8	93.8	115.1	94.5	114.1	95.8	149
150	120.5	89.4	119.8	90.3	118.2	92.4	116.6	94.4	115.9	95.1	114.9	96.4	150
151	121.3	90.0	120.6	90.9	119.0	93.0	117.3	95.0	116.7	95.8	115.7	97.1	151
152	122.1	90.6	121.4	91.5	119.8	93.6	118.1	95.7	117.5	96.4	116.4	97.7	152
153	122.9	91.1	122.2	92.1	120.5	94.2	118.9	96.3	118.2	97.0	117.2	98.4	153
154	123.7	91.7	123.0	92.7	121.3	94.8	119.7	96.9	119.0	97.7	118.0	99.0	154
155	124.5	92.3	123.8	93.3	122.1	95.4	120.5	97.5	119.8	98.3	118.7	99.6	155
156	125.3	92.9	124.6	93.9	122.9	96.0	121.2	98.2	120.6	98.9	119.5	100.3	156
157	126.1	93.5	125.4	94.5	123.7	96.7	122.0	98.8	121.3	99.6	120.3	100.9	157
158	126.9	94.1	126.2	95.1	124.5	97.3	122.8	99.4	122.1	100.2	121.0	101.0	158
159	127.7	94.7	127.0	95.7	125.3	97.9	123.6	100.1	122.9	100.8	121.8	102.2	159
160	128.5	95.3	127.8	96.3	126.1	98.5	124.3	100.7	123.6	101.5	122.6	102.8	160
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	4 P. 3 q.		53 deg.		52 deg.		51 Deg.		4 P. 1 h.		50 deg.		

Dif.	41 Deg. Lat.	41 Deg. dep.	42 Deg. Lat.	42 Deg. dep.	3 P. 3 q. Lat.	3 P. 3 q. dep.	43 Deg. Lat.	43 Deg. dep.	44 deg. Lat.	44 deg. dep.	4 Points Lat.	4 Points dep.	Dif.
1	00,8	00,7	00,7	00 7	00,7	00,7	00,7	00,7	00,7	00,7	00,7	00,7	1
2	01 5	01 3	01 5	01 3	01,5	01 3	01 5	01 4	01 4	01 4	01 4	01 4	2
3	02 3	02 0	02 2	02,0	02 2	02 0	02 2	02 0	02 2	02,1	02 1	02 1	3
4	03 0	02 6	03 0	02 7	03 0	02,7	03 0	02,7	02 9	02 8	02 8	02 8	4
5	03 8	03,3	03 7	03 3	03,7	03 4	03 7	03 4	03,0	03 5	03 5	03 5	5
6	04 5	03,9	04 5	04,0	04 4	04,0	04 4	04,1	04,3	04,2	04 2	04,2	6
7	05 3	04 6	05,2	04 7	05 2	04,7	05,1	04,8	05 0	04 9	04 9	04 9	7
8	06 0	05 2	05 9	05 4	05 9	05 4	05 9	05 5	05 8	05 6	05 7	05,7	8
9	06,3	05,9	06 7	06 0	06.7	06,0	06,6	06 1	06.5	06 3	06,4	06 4	9
10	07 5	06 6	07 4	06 7	07 4	06,7	07 3	06 8	07 2	06 9	07 1	07 1	10
11	08,3	07 2	08 2	07,4	08 2	07 4	08 0	07 5	07 9	07,0	07 8	07 8	11
12	09 1	07 9	08 9	08 0	09 9	08,1	08 8	08 2	08 6	08,3	08 5	08,5	12
13	09 8	08 5	09 7	08,7	09 6	08,7	09 5	08 9	09 3	09,0	09 2	09 2	13
14	10,6	09,2	10 4	09 4	10,4	09 4	10 2	09,5	10 1	09,7	09 9	09,9	14
15	11 3	09,8	11,1	10,0	11 1	10,1	11 0	10 2	10 8	10 4	10 6	10 6	15
16	12 1	10,5	11 9	10,7	11,9	10 7	11,7	10 9	11,5	11,1	11,3	11.3	16
17	12 8	11,2	12 6	11 4	12 6	11,4	12 4	11,6	12 2	11,8	12 0	12 0	17
18	13 6	11,8	13 4	12,0	13 3	12,1	13 2	12 3	12 9	12,5	12 7	12 7	18
19	14 3	12,5	14 1	12 7	14 1	12 8	13 9	13 0	13 7	13 2	13 4	13 4	19
20	15 1	13 1	14 9	13 4	14 8	13 4	14 6	13 6	14 4	13.9	14 1	14 1	20
21	15,8	13,8	15..	14 0	15 6	14 1	15 4	14,3	15,1	14,6	14,8	14 8	21
22	16 6	14 4	16 3	14 7	16,3	14 8	16,1	15 0	15,8	15 3	15,6	15 6	22
23	17 4	15 1	17 1	15 4	17 0	15 4	16 8	15 7	16 5	16,0	16 3	16 3	23
24	18 1	15,7	17 8	16 1	17,8	16 1	17 6	16,4	17 3	16 7	17 0	17 0	24
25	18 9	16 4	18 6	16 7	18 5	16,8	18 3	17 1	18 0	17 4	17,7	17 7	25
26	19 6	17,1	19 3	17 4	19,3	17 5	19,0	17 7	18 7	18,1	18 4	18,4	26
27	20 4	17,7	20 1	18 1	20,0	18 1	19 7	18 4	19 4	18,8	19 1	19,1	27
28	21,1	18 4	20,8	18 7	20 7	18,8	20 5	19,1	20,1	19,5	19 8	19 8	28
29	21 9	19 0	21,5	19,4	21 5	19,5	21,2	19 8	20 9	20 1	20 5	20 5	29
30	22 6	19 7	22 3	20,1	22.2	20,1	21 9	20 5	21 6	20,8	21 2	21 2	30
31	23 4	20 3	23,0	20 7	23 0	20,8	22 7	21 1	22 3	21,5	21 9	21,9	31
32	24 1	21 0	23 8	21 4	23,7	21 5	23 4	21 8	23 0	22 2	22 6	22 6	32
33	24 9	21 7	24 5	22 1	24 5	22,2	24 1	22 5	23 7	22,9	23 3	23 3	33
34	25 7	22 3	25 3	22 7	25,2	22 8	24 9	23,2	24 5	23 6	24 0	24 0	34
35	26 4	23 0	26 0	23 4	25,9	23 5	25 6	23,9	25,2	24,3	24 7	24 7	35
36	27,2	23 6	26,8	24 1	26,7	24 2	26 3	24 6	25 9	25 0	25,5	25 5	36
37	27 9	24,3	27 5	24,8	27,4	24,8	27 0	25 2	26 6	25 7	26,2	26 2	37
38	28 7	24,9	28 2	25 4	28,2	25 5	27 8	25 9	27 3	26 4	26 9	26,9	38
39	29 4	25 6	29 0	26 1	28,9	26 2	28 5	26 6	28 1	27,1	27 6	27 6	39
40	30.2	26 2	29 7	25 8	29,6	26,9	29 3	27 3	28 8	27 8	28 3	28 3	40
Dif.	dep	Lat.	dep.	Lat	dep.	Lat	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dif.
	49 Deg.		48 Deg.		4 P 1 q.		47 Deg.		46 deg.		4 Points		

Dist.	41 Deg. Lat.	dep.	42 Deg. Lat.	dep.	3 Pts. 39. Lat.	dep.	43 Deg. Lat.	dep.	44 Deg. Lat.	dep.	4 Points Lat.	dep.	Dist.
41	31,0	26,9	30,5	27,4	30,1	27,5	30,0	28,0	29,5	28,5	29,0	29,0	41
42	31 7	27 5	31 2	28 1	31 1	28 2	30 7	28 6	30 2	29 2	29 7	29 7	42
43	32 5	28 2	31 9	28 8	31 9	28 9	31 4	29 3	30 9	29 9	30 4	30 4	43
44	33 2	28 9	32 7	29 4	32 6	29 5	32 2	30 0	31 6	30 6	31 1	31 1	44
45	34 0	29 2	33 4	30 1	33 3	30 2	32 9	30 7	32 3	31 3	31 8	31 8	45
46	34 7	30 3	34 0	30 5	34 1	30 0	33 6	31 4	33 1	32 0	32 5	32 5	46
47	35 5	30 8	34 8	31 4	34 8	31 6	34 4	32 1	33 8	32 6	33 2	33 2	47
48	36 2	31 5	35 7	32 1	35 6	32 2	35 1	32 7	34 5	33 3	33 9	33 9	48
49	37 0	32 1	36 4	32 8	36 3	32 9	35 8	33 4	35 2	34 0	34 6	34 6	49
50	37 7	32 8	37 2	33 5	37 0	33 6	36 6	34 1	36 0	34 7	35 4	35 4	50
51	38,5	33,5	37,1	34,1	37,8	34,2	37,3	34,8	36,7	35,4	36,1	36,1	51
52	39 2	34 1	38 6	34 8	38 5	34 9	38 0	35 5	37 4	36 1	36 8	36 8	52
53	40 0	34 8	39 4	35 5	39 3	35 6	38 8	36 1	38 1	36 8	37 5	37 5	53
54	40 8	35 4	40 1	36 1	40 0	36 3	39 5	36 8	38 8	37 5	38 2	38 2	54
55	41 5	36 0	40 9	36 7	40 7	36 9	40 2	37 5	39 6	38 2	38 9	38 9	55
56	42 3	36 7	41 6	37 5	41 5	37 6	41 0	38 2	40 3	38 9	39 6	39 6	56
57	43 0	37 4	42 4	38 1	42 2	38 3	41 7	38 9	41 0	39 6	40 3	40 3	57
58	43 8	38 1	43 1	38 8	43 0	38 9	42 4	39 5	41 7	40 3	41 0	41 0	58
59	44 5	38 7	43 9	39 5	43 7	39 6	43 1	40 2	42 4	41 0	41 7	41 7	59
60	45 3	39 4	44 6	40 1	44 5	40 3	43 8	40 1	43 2	41 7	42 4	42 4	60
61	46,0	40,0	45,4	40,8	45,2	41,0	44,6	41,7	43,9	42,4	43,1	43,1	61
62	46 8	40 7	46 1	41 5	45 9	41 6	45 3	42 3	44 6	43 1	43 8	43 8	62
63	47 6	41 3	46 8	42 2	46 7	42 3	46 1	43 0	45 3	43 8	44 5	44 5	63
64	48 3	42 0	47 5	42 8	47 4	43 0	46 8	43 6	46 0	44 5	45 3	45 3	64
65	49 1	42 6	48 3	43 5	48 2	43 6	47 5	44 3	46 8	45 1	46 0	46 0	65
66	49 8	43 3	49 0	44 2	48 9	44 3	48 3	45 0	47 5	45 8	46 7	46 7	66
67	50 6	44 0	49 8	44 8	49 6	45 0	49 0	45 7	48 2	46 5	47 4	47 4	67
68	51 3	44 6	50 5	45 5	50 4	45 7	49 7	46 4	48 9	47 2	48 1	48 1	68
69	52 1	45 3	51 3	46 2	51 1	46 3	50 5	47 1	49 6	47 9	48 8	48 8	69
70	52 8	45 9	52 0	46 8	51 9	47 0	51 2	47 7	50 3	48 6	49 5	49 5	70
71	53,6	46,6	52,8	47,5	52,6	47,7	51,9	48,4	51,1	49,3	50,2	50,2	71
72	54 3	47 2	53 5	48 2	53 3	48 3	52 7	49 1	51 8	50 0	50 9	50 9	72
73	55 1	47 9	54 2	48 8	54 1	49 0	53 4	49 8	52 5	50 7	51 6	51 6	73
74	55 9	48 5	55 0	49 5	54 8	49 7	54 1	50 5	53 2	51 4	52 3	52 3	74
75	56 6	49 2	55 7	50 2	55 6	50 4	54 8	51 1	53 9	52 1	53 0	53 0	75
76	57 4	49 9	56 5	50 9	56 3	51 0	55 6	51 8	54 7	52 8	53 7	53 7	76
77	58 1	50 5	57 2	51 5	57 1	51 7	56 3	52 5	55 4	53 5	54 4	54 4	77
78	58 9	51 2	58 0	52 1	57 8	52 4	57 0	53 2	56 1	54 2	55 2	55 2	78
79	59 6	51 8	58 7	52 8	58 5	53 0	57 8	53 9	56 8	54 9	55 9	55 9	79
80	60 4	52 5	59 4	53 5	59 3	53 7	58 5	54 6	57 5	55 6	56 8	56 8	80
Dist.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	dep.	Lat.	Dist.
	49 Deg.		48 Deg.		4 P. 1 Q.		47 Deg.		46 Deg.		4 Points		

Dif.	41 Deg,		42 Deg.		3 P 39.		43 Deg,		44 Deg,		4 Points.		Dif.
	Lat,	dep,	Lat,	dep	Lat.	dep,	Lat.	dep	Lat,	dep	Lat.	dep,	
81	61.1	53.1	60.2	54,2	60.0	54.4	59,2	55.2	58,3	56,3	57,0	57.0	81
82	6. 9	53 8	60 9	54 9	60 8	55 1	60 0	55 9	59 0	57 0	57 6	57 6	82
83	62 6	54 5	61 7	55 5	61 5	55 7	60 7	56 6	59 7	57 6	58 3	58 3	83
84	63 4	55 1	62 4	56 2	62 2	56 4	61 4	57 3	60 4	58 3	59 0	59 0	84
85	64 2	55 9	63 2	56 9	63 0	57 1	62 2	58 0	61 1	59 0	60 8	60 8	85
86	64 9	56 4	63 9	57 5	63 7	57 7	63 0	58 6	61 9	59 7	61 5	61 5	86
87	65 7	57 1	64 7	58 2	64 5	58 4	63 6	59 3	62 6	60 4	62 2	62 2	87
88	66 4	57 7	65 4	58 9	65 2	59 1	64 4	60 0	63 3	61 1	62 8	62 8	88
89	67 2	58 4	66 1	59 6	65 9	59 8	65 1	60 7	64 0	61 8	63 6	63 6	89
90	67 9	59 0	66 9	60 2	66 7	60 4	65 8	61 4	64 7	62 5	64 3	64 3	90
91	68,7	59.7	67.6	60.8	67,4	61.1	66.5	62.1	65.5	63.2	65,0	65.0	91
92	69 4	60 4	68 4	61 6	68 2	61 8	67 3	62 7	66 2	63 9	65 8	65 8	92
93	70 2	61 0	69 1	62 1	68 9	62 4	68 0	63 4	66 9	64 6	66 5	66 5	93
94	71 0	61 7	69 9	62 9	69 6	63 1	68 7	64 1	67 6	65 3	67 2	67 2	94
95	71 7	62 3	70 6	63 6	70 4	63 8	69 5	64 8	68 4	66 0	67 9	67 9	95
96	72 5	63 0	71 3	64 2	71 1	64 5	70 2	65 5	69 1	66 7	68 6	68 6	96
97	73 2	63 6	72 1	64 9	71 9	65 1	70 9	66 1	69 8	67 4	69 3	69 3	97
98	74 0	64 3	72 8	65 6	72 6	65 8	71 7	66 8	70 5	68 1	70 0	70 0	98
99	74 7	65 9	73 6	66 2	73 4	66 5	72 4	67 5	71 2	68 9	70 7	70 7	99
100	75,5	65 6	74 3	66 9	74'1	67 2	73 1	68 2	71 9	69 5	71 4	71 4	100
101	76,2	66.3	75.0	67.6	74.8	67,8	73,9	68,9	72.6	70.2	72,1	72,1	101
102	77 0	66 9	75 8	68 2	75 6	68 5	74 6	69 5	73 4	70 8	72 8	72 8	102
103	77 7	67 6	76 5	68 9	76 3	69 2	75 3	70 2	74 1	71 5	73 5	73 5	103
104	78 5	68 2	77 3	69 6	77 0	69 8	76 1	70 9	74 8	72 2	74 2	74 2	104
105	79 2	68 9	78 0	70 2	77 8	70 5	76 8	71 6	75 6	72 9	74 9	74 9	105
106	80 0	69 5	78 7	70 9	78 5	71 2	77 5	72 3	76 2	73 6	75 7	75 7	106
107	80 8	70 2	79 5	71 6	79 3	71 8	78 3	73 0	77 0	74 3	76 4	76 4	107
108	81 5	70 8	80 2	72 3	80 0	72 5	79 0	73 6	77 7	75 0	77 1	77 1	108
109	82 3	71 5	81 0	72 9	80 7	73 2	79 7	74 3	78 4	75 7	77 8	77 8	109
110	83 0	72 2	81 7	73 6	81 5	73 9	80 4	75 0	79 1	76 4	78 5	78 5	110
111	83,8	72,8	82,5	74,3	82,2	74,5	81,2	75,7	79.8	77.1	79.2	79,2	111
112	84 5	73 5	83 2	74 9	83 1	75 2	81 9	56 4	80 6	77 8	79 9	79 9	112
113	85 3	74 1	83 9	75 6	83 7	75 9	82 6	77 1	81 3	78 5	80 6	80 6	113
114	86 0	74 8	84 7	76 3	84 4	76 5	83 4	77 7	82 0	79 2	81 1	81 1	114
115	86 8	75 4	85 4	76 9	85 2	77 0	84 1	78 4	82 7	79 9	82 8	82 8	115
116	87 5	76 1	86 2	77 6	85 9	77 9	84 8	79 1	83 4	80 6	82 7	82 7	116
117	88 3	76 7	86 9	78 3	86 7	78 6	85 6	79 8	84 2	81 3	83 4	83 4	117
118	89 1	77 4	87 7	78 9	87 4	79 2	86 3	80 5	84 9	82 0	84 1	84 1	118
119	89 8	78 1	88 4	79 6	88 2	79 9	87 0	81 2	85 6	82 7	84 8	84 8	119
120	90 6	78 7	89 1	80 3	88 9	80 6	87 8	81 8	86 3	83 4	85 6	85 6	120
Dif.	dep,	Lat	dep.	Lat.	dep,	Lat,	dep.	Lat,	dep.	Lat.	dep,	Lat,	Dif.
	49 Deg,		48 deg,		4 P. 1 q.		47 Deg.		46 Deg.		4 Points		

Dist.	41 Deg,		42 Deg,		3 P. 3 q.		43 Deg,		44 Deg,		4 Points	
	Lat.	dep,	Lat,	dep,	Lat,	dep,	Lat.	dep.	Lat,	dep.	Lat,	dep,
121	91,3	79,4	89,9	80,	89,6	81,2	88,5	82,5	87,0	84,0	86,3	86,3
122	92 1	80 0	90 6	81 0	90 3	81 9	89 2	83 2	87 8	84 7	87 0	87 0
123	92 8	80 7	91 4	82	91 1	82 6	90 0	83 9	88 5	85 4	87 7	87 7
124	93 6	81 3	92 1	83 0	91 9	83 3	90 7	84 5	89 2	86 1	88 4	88 4
125	94 3	82 0	92 9	83 6	92 6	83 9	91 4	85 2	89 9	86 8	89 1	89 1
126	95 1	82	93 6	84 3	93 3	84 6	92 1	85 9	90 6	87 5	89 8	99 8
127	95 8	83 3	94 3	85 0	94 1	85 3	92 9	86 5	91 4	88 2	90 5	90 5
128	96 6	84 0	95 1	85 6	94 8	85 9	93 6	87 3	92 1	88 9	91 2	91 2
129	97 4	84 6	95 8	86 3	95 6	86 6	94 3	88 0	92 8	89 6	91 9	91
130	98 1	85	96 6	87 0	96	87 3	95 1	88 6	93 5	90	92 6	92
131	98,9	85,	97,3	87,6	97,0	88 0	95,8	89,	94,2	91,0	93,3	93,
132	99 6	86 6	98 1	88 3	97 8	88 6	96 5	90 0	94 9	91 7	94	94 0
133	100 4	87 2	98 8	89 0	98 5	89 3	97 3	90 7	95	92 4	94	94 7
134	101 1	87 9	99 5	89 6	99 3	90 0	98 0	91 4	96 4	93 1	95 5	95 5
135	101 9	88 6	100 3	90 3	100 0	90 6	98 7	92 1	97 1	93 8	96 2	96 2
136	102 6	89 2	101 0	91 0	100 7	91 5	99 5	92 7	97 8	94 5	96 9	96 9
137	103 4	89 9	101 8	91 7	101 5	92 0	100 2	93 4	98 5	95 2	97 6	97 6
138	104 2	90 5	102 5	92 3	102 2	92 7	100 9	94 1	99 3	95 9	98 3	98 3
139	104 9	91 2	103 3	93 0	103 0	93 3	101 7	94 8	100 0	96 5	99 0	99 0
140	105 7	91 8	104 0	93 7	103 7	94 0	102 4	95 5	100 7	97 2	99 7	99 7
141	106,2	92,5	104,7	94,3	104,4	94,7	103,1	96,2	101,4	97,9	100,4	100,
142	107 4	93 1	105 5	95 0	105 2	95 3	103 9	96 8	102 1	98 6	101 1	101 1
143	107 9	93 8	106 2	95 7	105 9	96 0	104 6	97 5	102 5	99	101 8	101 8
144	108 7	94 5	107 0	96 3	106 7	96 7	105 3	98 2	103 6	100 0	102 5	102 5
145	109 4	95 1	107 7	97 0	107 4	97 4	106 0	98 9	104 3	100 7	103 2	103 2
146	110 2	95 8	108 5	97 7	108 2	98 0	106 8	99 5	105 0	101 4	103 9	103 9
147	110 9	96 4	109 2	98 3	108 9	98 7	107 5	100 2	105 7	102 1	104 6	104 6
148	111 7	97 1	109 9	99 0	1196	99 4	108 2	100 9	106 5	102 8	105 4	105 4
149	112 5	97 7	110 7	99 7	110 4	100 0	109 0	101 6	107 2	103 5	106 1	106 1
150	113 2	98 4	111 4	100 4	111 1	100 7	109 7	102 3	107 9	104 2	106 8	106 8
151	114,0	99,0	112,2	101,0	111,9	101,4	110 4	103,0	108,6	104,9	107,5	107,5
152	1147	997	1129	1017	1126	102 1	111 2	1036	1093	1056	1082	1082
153	1155	1004	1137	1024	1133	1027	1119	1043	110	1063	1089	1089
154	1162	1010	1144	1030	1141	1034	1126	1050	1108	1070	1096	1096
155	1170	1017	1151	1037	1148	1041	1134	1057	1115	1077	1103	1103
156	1177	1023	1159	1044	1156	1047	1141	1064	1122	1084	1110	1110
157	1185	1030	1166	1050	1163	1054	1148	1071	1129	1091	1117	1117
158	1192	1036	1174	1057	1170	1061	1156	1078	1136	1097	1124	1124
159	1200	1043	1181	1065	1178	1068	1163	1084	1144	1104	1131	1131
160	1208	1050	1189	1070	1185	1074	1170	1091	1151	1111	1138	1138
Dist.	dep,	Lat.	dep.	Lat,	dep,	Lat.	dep.	Lat.	dep,	Lat.	dep,	Lar,
	49 deg,		48 deg.		4 P. 1 q		47 Deg.		46 deg.		4 Points	

The Use and Explanation of the Table of Difference of Latitude and Departure.

THIS Table is of a large extent and well contrived, with many errors in other Tables corrected; it gives the difference of latitude and departure, in miles and tenths, to any distance not exceeding 160 miles, and to every degree and quarter point of the compass; and may be used to a greater distance, as will appear by the examples following.

The course stands at the head and foot of the table, at the head it begins at 1 deg. 2 deg. 1 quar. of a point &c. encreasing to 45 deg. or 4 points. At the foot it begins with 45 deg. or 4 points, so 46 deg. 47 deg. 4 points 1 quarter &c. encreasing backwards to 90 degrees or 8 points; the distance stands in the first and last columns, under the title Dist. which on the left hand page begins at 1 and runs to 40, on the right hand page it begins at 41 and runs to 80 &c. The difference of latitude and departure stands under the course at the head, and over it at the foot of the table.

N. B. The blanks left in several columns of this table, are supplied by the figures next over them in the columns of difference of latitude and departure.

A few Examples will make it Plain.

Example 1st. If the course be S E. by S. 1 q. E. and distance 46 miles, required the difference of latitude and departure.

On the right hand page (because the distance is above 40) find the distance in the first or last column, and the course at the top, (being less than 4 points or 45 degrees) look for the course three points and 1 quarter, and right under it, and against 46, the distance sailed, will be found in column lat. 36,9 for the difference of latitude; and in the column dep. 27,4 for the departure.

Example 2d. Suppose the ship's course be W. S. W. 1 quarter W. and the distance 345 miles.

First, divide the distance by 3 makes 115, and find the course at the bottom, as being above 4 points or 45 degrees; and against the third part distance 115, is found the difference of latitude 38,8, and departure 108; then multiply this difference of latitude and departure by 3, gives, 38,8 × 3 equal 116,4, and 108 × 3 equal 324, then is the true difference of latitude 116,4 and departure 324 as was required.

Example 3d. Let the course be S. 51 deg. easterly, and distance 396 miles; Then 396 ÷ 3 is 132, then find the course at the bottom, against 132 in first column, you have Dep. 102.6, and Lat. 83.1. and each multiplied by 3, that is 102,6 × 3 equal 307,8 for departure, and 83,1 × 3 equal 249,3 the difference of latitude.

A

TABLE,

OF

MERIDIONAL PARTS,

To every Degree and Minute of the MERIDIAN,

For performing ſeveral Caſes in NAVIGATION according to Mercator, or more properly Mr. *Wright*'s Projection.

M	1	2	3	4	5	6	7	8	9	10	M
	min.	min.	min.	min.	min.	min.	min.	min.	min.	min.	
0	00	0120	0180	0240	0300	0360	0421	0482	0542	0603	0
1	61	0121	0181	0241	0301	0362	0422	0483	0543	0604	1
2	62	0122	0182	0242	0302	0363	0423	0484	0544	0605	2
3	63	0123	0183	0243	0303	0364	0424	0485	0545	0606	3
4	64	0124	0184	0244	0304	0365	0425	0486	0546	0607	4
5	65	0125	0185	0245	0305	0366	0426	0487	0547	0608	5
6	66	0126	0186	0246	0306	0367	0427	0488	0548	0609	6
7	67	0127	0187	0247	0307	0368	0428	0489	0549	0610	7
8	68	0128	0188	0248	0308	0369	0429	0490	0550	0611	8
9	69	0129	0189	0249	0309	0370	0430	0491	0551	0612	9
10	70	0130	0190	0250	0310	0371	0431	0492	0552	0613	10
11	71	0131	0191	0251	0311	0372	0432	0493	0553	0614	11
12	72	0132	0192	0252	0312	0373	0433	0494	0554	0615	12
13	73	0133	0193	0253	0313	0374	0434	0495	0555	0616	13
14	74	0134	0194	0254	0314	0375	0435	0496	0556	0617	14
15	75	0135	0195	0255	0315	0376	0436	0497	0557	0618	15
16	76	0136	0196	0256	0316	0377	0437	0498	0558	0619	16
17	77	0137	0197	0257	0317	0378	0438	0499	0559	0620	17
18	78	0138	0198	0258	0318	0379	0439	0500	0560	0621	18
19	79	0139	0199	0259	0319	0380	0440	0501	0561	0622	19
20	80	0140	0200	0260	0320	0381	0441	0502	0562	0623	20
21	81	0141	0201	0261	0321	0382	0442	0503	0563	0624	21
22	82	0142	0202	0262	0322	0383	0443	0504	0564	0625	22
23	83	0143	0203	0263	0323	0384	0444	0505	0565	0626	23
24	84	0144	0204	0264	0324	0385	0445	0506	0566	0627	24
25	85	0145	0205	0265	0325	0386	0446	0507	0567	0628	25
26	86	0146	0206	0266	0326	0387	0447	0508	0568	0629	26
27	87	0147	0207	0267	0327	0388	0448	0509	0569	0630	27
28	88	0148	0208	0268	0328	0389	0449	0510	0570	0631	28
29	89	0149	0209	0269	0329	0390	0450	0511	0571	0632	29
M	min.	min.	min.	min.	min.	min.	min.	min.	min.	min.	M
	1	2	3	4	5	6	7	8	9	10	

M	1 Min.	2 Min.	3 Min.	4 Min.	5 Min.	6 Min.	7 Min.	8 Min.	9 Min.	10 Min.	M
30	90	0150	0210	0270	0330	0391	0451	0512	0573	0634	30
31	91	0151	0211	0271	0332	0392	0452	0513	0574	0635	31
32	92	0152	0212	0272	0333	0393	0453	0514	0575	0636	32
33	93	0153	0213	0273	0334	0394	0454	0515	0576	0637	33
34	94	0154	0214	0274	0335	0395	0455	0516	0577	0638	34
35	95	0155	0215	0275	0336	0396	0456	0517	0578	0639	35
36	96	0156	0216	0276	0337	0397	0457	0518	0579	0640	36
37	97	0157	0217	0277	0338	0398	0458	0519	0580	0641	37
38	98	0158	0218	0278	0339	0399	0459	0520	0581	0642	38
39	99	0159	0219	0279	0340	0400	0460	0521	0582	0643	39
40	100	0160	0220	0280	0341	0401	0461	0522	0583	0644	40
41	101	0161	0221	0281	0342	0402	0462	0523	0584	0645	41
42	102	0162	0222	0282	0343	0403	0463	0524	0585	0646	42
43	103	0163	0223	0283	0344	0404	0464	0525	0586	0647	43
44	104	0164	0224	0284	0345	0405	0465	0526	0587	0648	44
45	105	0165	0225	0285	0346	0406	0466	0527	0588	0649	45
46	106	0166	0226	0286	0347	0407	0467	0528	0589	0650	46
47	107	0167	0227	0287	0348	0408	0468	0529	0590	0651	47
48	108	0168	0228	0288	0349	0409	0469	0530	0591	0652	48
49	109	0169	0229	0289	0350	0410	0470	0531	0592	0653	49
50	110	0170	0230	0290	0351	0411	0471	0532	0593	0654	50
51	111	0171	0231	0291	0352	0412	0472	0533	0594	0655	51
52	112	0172	0232	0292	0353	0413	0473	0534	0595	0656	52
53	113	0173	0233	0293	0354	0414	0474	0535	0596	0657	53
54	114	0174	0234	0294	0355	0415	0475	0536	0597	0658	54
55	115	0175	0235	0295	0356	0416	0476	0537	0598	0659	55
56	116	0176	0236	0296	0357	0418	0478	0538	0599	0660	56
57	117	0177	0237	0297	0358	0419	0479	0539	0600	0661	57
58	118	0178	0238	0298	0359	0420	0480	0540	0601	0662	58
59	119	0179	0239	0299	0360	0421	0481	0541	0602	0663	59
M	Min.	Min.	Min.	Min	Min	Min	Min	Min.	Min	Min	M
	1	2	3	4	5	6	7	8	9	10	

M	11	12	13	14	15	16	17	18	19	20	M
	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	
0	0664	0725	0787	0849	0910	0973	1033	1098	1161	1225	0
1	0665	0726	0788	0849	0911	0974	1036	1099	1163	1226	1
2	0666	0727	0789	0851	0913	0975	1037	1100	1164	1227	2
3	0667	0728	0790	0852	0914	0976	1038	1101	1165	1228	3
4	0668	0729	0791	0853	0915	0977	1039	1102	1166	1229	4
5	0669	0730	0792	0854	0916	0978	1041	1103	1167	1230	5
6	0670	0731	0793	0855	0917	0979	1042	1105	1168	1232	6
7	0671	0732	0794	0856	0918	0980	1043	1106	1169	1233	7
8	0672	0733	0795	0857	0919	0981	1044	1107	1170	1234	8
9	0673	0735	0796	0858	0920	0982	1045	1108	1171	1235	9
10	0674	0736	0797	0859	0921	0983	1046	1109	1172	1236	10
11	0675	0737	0798	0860	0922	0984	1047	1110	1173	1237	11
12	0676	0738	0799	0861	0923	0985	1048	1111	1174	1238	12
13	0677	0739	0800	0862	0924	0986	1049	1112	1175	1239	13
14	0678	0740	0801	0863	0925	0987	1050	1113	1176	1240	14
15	0679	0741	0802	0864	0926	0988	1051	1114	1177	1241	15
16	0680	0742	0803	0865	0927	0989	1052	1115	1178	1242	16
17	0681	0743	0804	0866	0928	0990	1053	1116	1179	1243	17
18	0682	0744	0805	0867	0929	0991	1054	1117	1181	1244	18
19	0683	0745	0806	0868	0930	0992	1055	1118	1182	1245	19
20	0684	0746	0807	0879	0931	0994	1056	1119	1183	1246	20
21	0685	0747	0808	0870	0932	0995	1057	1120	1184	1248	21
22	0686	0748	0809	0871	0933	0996	1058	1121	1185	1249	22
23	0688	0749	0810	0872	0934	0997	1059	1122	1186	1250	23
24	0689	0750	0811	0873	0935	0998	1060	1123	1187	1251	24
25	0690	0751	0812	0874	0936	0999	1061	1125	1188	1252	25
26	0691	0752	0813	0875	0937	1000	1063	1126	1189	1253	26
27	0692	0753	0814	0876	0938	1001	1064	1127	1190	1254	27
28	0693	0754	0816	0877	0939	1002	1065	1128	1191	1255	28
29	0694	0755	0817	0878	0941	1003	1066	1129	1192	1256	29
M	Min.	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	11	12	13	14	15	16	17	18	19	20	

M	11 Min	12 Min	13 Min	14 Min	15 Min.	16 Min	17 Min	18 Min	19 Min	20 Min	
30	0695	0756	08 8	0879	0942	1004	1067	1130	1193	1257	30
31	0696	0757	0819	0880	0943	1005	1068	1131	1194	1258	31
32	0697	0758	0820	0881	0944	1006	1069	1132	1195	1259	32
33	0698	0759	0821	0883	0945	1007	1070	1133	1196	1260	33
34	0699	0760	0822	0884	0946	1008	1071	1134	1197	1261	34
35	0700	0761	0823	0885	0947	1009	1072	1135	1199	1262	35
36	0701	0762	0824	0886	0948	1010	1073	1136	1200	1264	36
37	0702	0763	0825	0887	0949	1011	1074	1137	1201	1265	37
38	0703	0764	0826	0888	0950	1012	1075	1138	1202	1266	38
39	0704	0765	0827	0889	0951	1013	1076	1139	1203	1267	39
40	0705	0766	0828	0890	0952	1014	1077	1140	1204	1268	40
41	0706	0767	0829	0891	0953	1015	1078	1141	1205	1269	41
42	0707	0768	0830	0892	0954	1016	1079	1142	1206	1270	42
43	0708	0769	0831	0893	0955	1018	1080	1144	1207	1271	43
44	0709	0770	0832	0894	0956	1019	1081	1145	1208	1272	44
45	0710	0771	0833	0895	0957	1020	1082	1146	1209	1273	45
46	0711	0772	0834	0896	0958	1021	1083	1147	1210	1274	46
47	0712	0773	0835	0897	0959	1022	1085	1148	1211	1275	47
48	0713	0774	0836	0898	0960	1023	1086	1149	1212	1276	48
49	0714	0775	0837	0899	0961	1024	1087	1150	1213	1277	49
50	0715	0776	0838	0900	0962	1025	1088	1151	1214	1278	50
51	0716	0777	0839	0901	0963	1026	1089	1152	1216	1280	51
52	0717	0779	0840	0902	0964	1027	1090	1153	1217	1281	52
53	0718	0780	0841	0903	0965	1028	1091	1154	1218	1282	53
54	0719	0781	0842	0904	0966	1029	1092	1155	1219	1283	54
55	0720	0782	0843	0905	0968	1030	1093	1156	1220	1284	55
56	0721	0783	0844	0906	0969	1031	1094	1157	1221	1285	56
57	0722	0784	0845	0907	0970	1032	1095	1158	1222	1286	57
58	0723	0785	0846	0908	0971	1033	1096	1159	1223	1287	58
59	0724	0786	0847	0909	0972	1034	1097	1160	1224	1288	59
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	11	12	13	14	15	16	17	18	19	20	

M	21	22	23	24	25	26	27	28	29	30	M
	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	
0	1289	1354	1419	1484	1550	1616	1684	1751	1819	1888	0
1	1290	1355	1420	1485	1551	1618	1685	1752	1821	1890	1
2	1291	1356	1421	1486	1552	1619	1686	1753	1822	1891	2
3	1292	1357	1422	1487	1553	1620	1687	1755	1823	1892	3
4	1293	1358	1423	1488	1554	1621	1688	1756	1824	1893	4
5	1295	1359	1424	1490	1556	1622	1689	1757	1825	1894	5
6	1296	1360	1425	1491	1557	1623	1690	1758	1826	1895	6
7	1297	1351	1426	1492	1558	1624	1691	1759	1827	1896	7
8	1298	1362	1427	1493	1559	1625	1693	1700	1829	1898	8
9	1299	1363	1428	1494	1560	1626	1694	1761	1830	1899	9
10	1300	1364	1429	1495	1561	1628	1695	1762	1831	1900	10
11	1301	1366	1431	1496	1562	1629	1696	1764	1832	1901	11
12	1302	1367	1432	1497	1563	1630	1697	1765	1833	1902	12
13	1303	1368	1433	1498	2564	1631	1698	1766	1834	1903	13
14	1304	1369	1434	1499	1565	1632	1699	1767	1835	1905	14
15	1305	1370	1435	1500	1567	1633	1700	1768	1837	1906	15
16	1306	1371	1436	1502	1568	1634	1701	1769	1838	1907	16
17	1307	1372	1437	1503	1569	1635	1703	1770	1839	1908	17
18	1308	1373	1438	1504	1570	1637	1704	1772	1840	1909	18
19	1310	1374	1439	1505	1571	1638	1705	1773	1841	1910	19
20	1311	1375	1440	1500	1572	1639	1706	1774	1842	1911	20
21	1312	1376	1441	1507	1573	1640	1707	1775	1843	1913	21
22	1513	1377	1443	1508	1574	1641	1708	1776	1845	1914	22
23	1314	1379	1444	1509	1575	1642	1709	1777	1846	1915	23
24	1315	1380	1445	1510	1577	1643	1710	1778	1847	1916	24
25	1316	1381	1446	1511	1578	1644	1712	1780	1848	1917	25
26	1317	1382	1447	1513	1579	1645	1713	1781	1849	1918	26
27	1318	1383	1448	1514	1580	1647	1714	1782	1850	1920	27
28	1319	1384	1449	1515	1581	1648	1715	1783	1852	1921	28
29	1320	1385	1450	1516	1582	1649	1716	1784	1853	1922	29
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	22	22	23	24	25	26	27	28	29	20	

M	21 Min.	22 Min.	23 Min.	24 Min.	25 Min	26 Min	27 Min	28 Min	29 Min	30 Min	M
30	1321	1386	1451	1517	1583	1650	1717	1785	1854	1923	30
31	1322	1387	1452	1518	1584	1651	1718	1786	1855	1924	31
32	1324	1388	1453	1519	1585	1652	1720	1787	1856	1925	32
33	1325	1389	1455	1520	1586	1653	1721	1789	1857	1927	33
34	1326	1390	1450	1521	1588	1654	1722	1790	1858	1928	34
35	1327	1392	1457	1522	1589	1656	1723	1791	1860	1929	35
36	1328	1393	1458	1524	1590	1657	1724	1792	1861	1930	36
37	1329	1394	1459	1525	1591	1658	1725	1793	1862	1931	37
38	1330	1395	1460	1526	1592	1659	1726	1794	1863	1932	38
39	1331	1396	1461	1527	1593	1660	1727	1795	1864	1933	39
40	1332	1397	1462	1528	1594	1661	1729	1797	1865	1935	40
41	1333	1398	1463	1529	1595	1662	1730	1798	1866	1936	41
42	1334	1399	1464	1530	1596	1663	1731	1799	1868	1937	42
43	1335	1400	1465	1531	1598	1664	1732	1800	1869	1938	43
44	1336	1401	1467	1532	1599	1666	1733	1801	1870	1939	44
45	1338	1402	1468	1533	1600	1667	1734	1802	1871	1941	45
46	1339	1403	1469	1535	1601	1668	1735	1803	1872	1942	46
47	1340	1405	1470	1536	1602	1669	1736	1805	1873	1943	47
48	1341	1406	1471	1537	1603	1670	1738	1806	1875	1944	48
49	1342	1407	1472	1538	1604	1671	1739	1807	1876	1945	49
50	1343	1408	1473	1539	1605	1672	1740	1808	1877	1946	50
51	1344	1409	1474	1540	1606	1673	1741	1809	1878	1948	51
52	1345	1410	1475	1541	1608	1675	1742	1810	1879	1949	52
53	1346	1411	1476	1542	1609	1676	1743	1811	1880	1950	53
54	1347	1412	1477	1543	1610	1677	1744	1813	1881	1951	54
55	1348	1413	1479	1544	1611	1678	1745	1814	1883	1952	55
56	1349	1414	1480	1546	1612	1679	1747	1815	1884	1953	56
57	1350	1415	1481	1547	1613	1680	1748	1816	1885	1955	57
58	1352	1416	1482	1548	1614	1681	1749	1817	1886	1956	58
59	1353	1418	1483	1549	1615	1682	1750	1818	1887	1957	59
M	Min.	Min.	Min.	Min	Min	Min	Min	Min.	Min	Min	M
	21	22	23	24	25	26	27	28	29	30	

M	31 min.	32 min.	33 min.	34 min.	35 min.	36 min.	37 min.	38 min.	39 min.	40 min.	M
0	1958	2028	2.00	2171	2244	2318	2393	.,68	2545	2623	0
1	1959	2030	2101	2173	2245	2319	2394	2470	2546	2624	1
2	1960	2031	2102	2174	2247	2320	2395	2471	2548	2625	2
3	1962	2032	2103	2175	2248	2322	2396	2472	2549	2627	3
4	1963	2033	2104	2176	2249	2323	2398	2473	2550	2628	4
5	1964	2034	2105	2178	2250	2324	2399	2475	255:	2629	5
6	1965	2035	2107	2179	2252	2325	2400	2476	2553	2631	6
7	1966	2037	2108	2180	2253	2327	2401	2477	2554	2632	7
8	1967	2038	2109	2181	2254	2328	2403	2478	2555	2633	8
9	1969	2039	2110	2182	2255	2329	2404	2480	2557	2634	9
10	1970	2040	2111	2184	2256	2330	2405	2481	2558	2636	10
11	1971	2041	2113	2185	2258	2332	2406	2482	2559	2637	11
12	1972	2043	2114	2186	2259	2333	2408	2484	2560	2638	12
13	1973	2044	2115	2187	2260	2334	2409	2485	2562	2640	13
14	1974	2045	2116	2188	2261	2335	2410	2486	2563	2641	14
15	1976	2046	2117	2190	2263	2337	2411	2487	2564	2642	15
16	1977	2047	2119	2191	2264	2338	2413	2489	2566	2643	16
17	1978	2048	2120	2192	2265	2339	2414	2490	2567	2645	17
18	1979	2050	2121	2193	2266	2340	2415	2491	2568	2646	18
19	1980	2051	2122	2194	2268	2342	2416	2492	2569	2648	19
20	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	20
21	1983	2053	2125	2197	2270	2344	2419	2495	2572	2650	21
22	1984	2054	2126	2198	2271	2345	2420	2496	2573	2651	22
23	1985	2056	2127	2199	2272	2346	2421	2498	2575	2653	23
24	1986	2057	2128	2200	2274	2348	2423	2499	2576	2654	24
25	1987	2058	2129	2202	2275	2349	2424	2500	2577	2655	25
26	1988	2059	2131	2203	2276	2350	2425	2501	2578	2657	26
27	1990	2060	2132	2204	2277	2351	2427	2503	d580	2658	27
28	1991	2061	2133	2205	2279	2353	2428	2504	2581	2659	28
29	1992	2063	2134	2207	2280	2354	2429	2505	2582	2661	29
M	min.	min.	min.	min.	min.	min.	min.	min.	min.	min.	M
	31	32	33	34	35	36	37	38	39	40	

M	31 Min	32 Min	33 Min	34 Min	35 Min.	36 Min	37 Min.	38 Min	39 Min	40 Min	M
30	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	30
31	1994	2065	2137	2209	2282	2356	2432	2508	2585	2663	31
32	1995	2066	2138	2210	2283	2358	2433	2509	2586	2665	32
33	1997	2067	2139	2211	2285	2359	2434	2510	2588	2666	33
34	1998	2069	2130	2213	2286	2360	2435	2512	2589	2667	24
35	1999	2070	2141	2214	2287	2361	2437	2513	2590	2669	35
36	2000	2071	2143	2215	2288	2363	2438	2514	2591	2670	36
37	2001	2072	2144	2216	2290	2364	2439	2515	2593	2671	37
38	2002	2073	2145	2217	2291	2365	2440	2517	2594	2673	38
39	2004	2075	2146	2219	2292	2366	2442	2518	2595	2674	39
40	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	40
41	2006	2077	2149	2221	2295	2369	2444	2521	2598	2676	41
42	2007	2078	2150	2222	2296	2370	2445	2522	2599	2678	42
43	2008	2079	2151	2224	2297	2371	2447	2523	2601	2679	43
44	2010	2080	2152	2225	2298	2373	2448	2524	2602	2680	44
45	2011	2082	2153	2226	2299	2374	2449	2526	2603	2681	45
46	2012	2083	2155	2227	2301	2375	2451	2527	2604	2683	46
47	2013	2084	2156	2228	2302	2376	2452	2528	2605	2684	47
48	2014	2085	2157	2230	2303	2378	2453	2530	2607	2686	48
49	2015	2086	2158	2231	2304	2379	2454	2531	2608	2687	49
50	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	50
51	2018	2089	2161	2233	2307	2381	2457	2533	2611	2690	51
52	2019	2090	2162	2235	2308	2383	2458	2535	2612	2691	52
53	2020	2091	2163	2236	2309	2384	2459	2536	2614	2692	53
54	2021	2092	2164	2237	2311	2385	2461	2537	2615	2694	54
55	2022	2094	2165	2238	2312	2386	2462	2538	2616	2695	55
56	2024	2095	2167	2239	2313	2388	2463	2540	2617	2696	56
57	2025	2096	2168	2241	2214	2389	2464	2541	2619	2698	57
58	2026	2097	2169	2242	2316	2390	2466	2542	2620	2699	58
59	2027	2098	2170	2243	2317	2391	2467	2544	2621	2700	59
M	Min.	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	31	32	33	34	35	36	37	38	39	40	

M	41 Min	42 Min	43 Min	44 Min	45 Min	46 Min	47 Min	48 Min	49 Min	50 Min	M
0	2702	2782	2863	2946	3030	3116	3203	3292	3382	3474	0
1	03	83	64	47	31	17	04	93	84	76	1
2	04	84	66	49	33	18	06	95	85	78	2
3	06	86	67	50	34	20	07	96	87	79	3
4	07	87	69	51	36	21	09	98	88	81	4
5	08	88	70	53	37	23	10	99	90	82	5
6	10	90	71	54	38	24	12	3301	91	84	6
7	11	91	73	56	40	26	13	02	93	85	7
8	12	92	74	57	41	27	14	03	94	87	8
9	2714	2794	2875	2958	3043	3129	3216	3305	3396	3488	9
10	2715	2796	2877	2960	3044	3130	3217	3306	3397	3490	10
11	16	97	78	61	46	31	19	08	99	92	11
12	18	98	80	63	47	33	20	09	3400	93	12
13	19	99	81	64	48	34	22	11	02	95	13
14	20	2801	82	65	50	36	23	12	03	96	14
15	22	02	84	67	51	37	25	14	05	98	15
16	23	03	85	68	53	39	26	16	07	99	16
17	24	05	86	70	54	40	28	17	08	3501	17
18	26	06	88	71	55	42	29	19	10	03	18
19	2727	2807	2889	2972	3057	3143	3231	3320	3411	3504	19
20	2728	2809	2891	2974	3058	3144	3232	3322	3413	3506	20
21	29	10	92	75	60	46	34	23	14	07	21
22	31	11	93	76	61	47	35	25	16	09	22
23	32	13	95	78	63	49	36	26	17	10	23
24	33	14	96	79	64	50	38	28	19	12	24
25	35	15	97	81	65	52	40	29	20	14	25
26	36	17	99	82	67	53	41	31	22	16	26
27	37	18	2900	83	68	55	42	32	23	17	27
28	39	20	2902	85	70	56	44	34	25	18	28
29	2740	2821	2903	2986	3071	3157	3245	3335	3427	3520	29
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	41	42	43	44	45	46	47	48	49	50	

M	41 Min.	42 Min	43 Min.	44 Min.	45 Min	46 Min	47 Min	48 Min	49 Min	50 Min	M
30	2742	2822	2904	2988	3073	3159	3247	3337	[illegible]	[illegible]	30
31	43	24	06	89	74	60	48	38	30	22	31
32	45	25	07	91	75	62	50	40	31	23	32
33	46	26	08	92	77	63	51	41	33	26	33
34	47	28	10	93	78	65	53	43	34	28	34
35	48	29	11	95	80	66	54	44	36	29	35
36	50	30	13	96	81	68	56	46	37	31	36
37	51	31	14	98	83	69	57	47	39	32	37
38	53	33	15	99	84	71	59	49	40	34	38
39	2754	2834	2917	3000	3185	3172	3260	3350	3442	3536	39
40	2755	2836	2918	3002	3187	3173	3262	3352	3443	3537	40
41	56	37	19	03	88	75	63	53	45	39	41
42	58	39	21	05	90	76	65	55	47	40	42
43	59	40	22	06	91	78	66	56	48	41	43
44	60	41	24	07	93	79	68	58	50	43	44
45	62	43	25	09	94	81	69	59	51	45	45
46	63	44	26	10	95	82	71	61	53	47	46
47	64	45	28	12	97	84	72	62	54	48	47
48	66	47	29	13	98	85	74	64	56	50	48
49	2767	2848	2931	3014	3100	3187	3275	3365	3457	3551	49
50	2768	2849	2932	3016	3101	3188	3277	3367	3459	3553	50
51	70	51	33	17	03	90	78	68	60	55	51
52	71	52	35	19	04	91	80	70	62	56	52
53	72	54	36	20	05	92	81	71	64	58	53
54	74	55	37	21	07	94	83	73	65	59	54
55	75	56	39	23	08	95	84	74	67	60	55
56	76	58	40	24	10	97	86	76	68	62	56
57	78	59	42	26	11	98	87	78	70	64	57
58	79	60	43	27	13	3200	89	79	71	65	58
59	2780	2862	2944	3028	3114	3201	3290	3381	3472	3567	59
M	Min.	Min.	Min.	Min	Min	Min	Min	Min.	Min	Min	M
	41	42	43	44	45	46	47	48	49	50	

M	51 min.	52 min.	53 min.	54 min.	55 min.	56 min.	57 min.	58 min.	59 min.	60 min.	M
0	3569	3665	1764	3865	3968	4074	4183	4294	4409	4527	0
1	70	67	65	66	70	76	84	96	11	29	1
2	72	68	67	68	71	77	86	98	13	31	2
3	74	70	69	70	73	79	88	4300	15	33	3
4	75	72	70	71	75	81	90	02	17	35	4
5	77	73	72	73	77	83	92	04	19	37	5
6	78	75	74	75	78	84	94	06	21	39	6
7	80	77	75	77	80	86	95	08	23	41	7
8	82	78	77	78	82	88	97	09	25	43	8
9	3583	3680	3779	3880	3984	4090	4199	4311	4427	4545	9
10	3585	3681	3780	3882	3985	4092	4201	4313	4429	4547	10
11	86	83	82	83	87	94	03	15	31	49	11
12	88	85	84	85	89	95	05	17	33	51	12
13	90	86	85	87	91	97	07	19	34	53	13
14	91	88	87	89	92	99	08	21	36	55	14
15	93	90	89	90	94	4101	10	23	38	57	15
16	94	92	90	92	96	03	12	25	40	59	16
17	96	93	91	94	98	04	14	27	42	62	17
18	98	95	94	95	99	06	16	28	44	64	18
19	3599	3696	3795	3897	4001	4008	4218	4330	4446	4566	19
20	3601	3698	3797	3899	4003	4110	4220	4332	4448	4568	20
21	02	99	99	3901	05	12	21	34	50	70	21
22	04	3701	3800	02	06	13	23	36	52	72	22
23	06	03	02	04	08	15	25	38	54	74	23
24	07	04	04	06	10	17	27	40	56	76	24
25	09	06	06	07	12	19	29	42	58	78	25
26	10	08	07	09	14	21	31	44	60	80	26
27	12	09	09	11	15	22	32	46	62	82	27
28	14	11	11	14	17	24	34	47	64	84	28
29	3615	3713	3812	3914	4019	4126	4236	4349	4466	4586	29
M	min.	min.	min.	min.	min.	min.	min.	min.	min.	min.	M
	51	52	43	54	55	56	57	58	59	60	

M	51	52	53	54	55	56	57	58	59	60	M
	Min	Min	Min	Min	Min.	Min	Min.	Min	Min	Min	
30	3617	3714	3814	3916	4021	4128	4238	4351	4468	4588	30
31	18	16	16	18	22	30	40	53	70	90	31
32	20	17	17	19	24	32	42	55	72	91	32
33	22	19	19	21	26	33	44	57	74	94	33
34	2	21	21	23	28	35	46	59	76	96	24
35	25	22	22	25	29	37	47	61	78	98	35
36	26	24	24	26	31	39	49	63	80	4600	36
37	28	26	26	28	33	41	51	66	82	02	37
38	30	27	27	30	35	42	53	67	84	04	38
39	3631	3729	3829	3932	4037	4144	4255	4369	4486	4606	39
40	3633	3731	3831	9[illegible]	038	4142	4257	4370	4488	4608	40
41	34	32	32	35	40	48	59	72	90	10	41
42	36	34	34	37	41	50	60	74	92	12	42
43	38	36	36	38	43	52	62	76	94	14	43
44	39	37	38	40	45	53	64	78	95	16	44
45	41	39	39	42	47	55	66	80	97	18	45
46	43	41	41	4[illegible]	49	57	68	82	99	20	46
47	44	42	43	45	51	59	70	84	4501	23	47
48	46	44	44	47	52	61	72	86	03	25	48
49	3647	3746	3846	3949	4054	4162	4274	4388	4504	4627	49
50	3649	3747	3848	3951	4056	4164	4275	4390	4507	4629	50
51	51	49	49	52	58	66	77	92	09	31	51
52	52	50	51	54	60	68	79	94	11	33	52
53	54	52	53	56	61	70	81	96	13	35	53
54	55	54	54	58	63	72	83	98	14	37	54
55	57	55	56	59	65	73	85	99	17	39	55
56	59	57	58	61	67	75	87	4401	19	41	56
57	60	59	60	63	69	77	89	03	21	43	57
58	62	60	61	64	70	79	91	05	23	45	58
59	3664	3762	3863	3966	4072	4181	4293	4407	4525	4647	60
M	Min.	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	51	52	53	54	55	56	57	58	59	60	

M	61	62	63	64	65	66	67	68	69	70	M
	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	
0	4649	4775	4905	5039	5179	5324	5574	5031	5795	5966	0
1	51	77	07	42	81	26	77	33	97	69	1
2	53	79	09	44	84	28	79	36	5800	72	2
3	55	81	12	46	86	31	82	39	03	75	3
4	57	84	14	49	88	33	84	42	06	78	4
5	60	86	16	51	91	36	87	44	09	81	5
6	62	88	18	53	93	38	89	47	11	84	6
7	64	90	20	55	95	41	92	50	14	86	7
8	66	91	23	58	98	43	95	52	17	89	8
9	4668	4794	4925	5060	5200	5346	5597	5655	5820	5992	9
10	4670	4796	4927	5062	5203	5348	5500	5658	5823	5995	10
11	72	98	29	65	05	51	02	60	25	98	11
12	74	4801	31	67	07	53	05	63	28	6001	12
13	76	03	34	69	10	56	07	66	31	04	13
14	78	05	36	71	12	58	10	68	34	07	14
15	80	07	38	74	14	61	13	71	37	10	15
16	82	09	40	76	17	63	15	74	39	13	16
17	84	11	43	78	19	66	18	76	42	16	17
18	87	14	45	81	22	68	20	79	45	19	18
19	4689	4816	4947	5083	5224	5371	5523	5682	5848	6022	19
20	4691	4818	4949	5085	5226	5373	5526	5685	5851	6025	20
21	93	20	51	88	29	76	28	87	54	28	21
22	95	22	54	90	31	78	31	90	56	31	22
23	97	24	56	92	34	80	33	93	59	34	23
24	99	26	58	95	36	83	36	95	62	37	24
25	4701	29	60	97	38	85	39	98	65	40	25
26	03	31	63	99	41	88	41	5701	68	43	26
27	05	33	65	5102	43	90	44	04	71	46	27
28	07	35	67	04	46	93	46	06	74	49	28
29	4710	4837	4969	5106	5248	5395	5549	5709	5876	6052	29
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	61	62	63	64	65	66	67	68	69	70	

M	61 Min.	62 Min.	63 Min	64 Min.	65 Min	66 Min	67 Min	68 Min	69 Min	70 Min	M
30	4712	4839	4972	5108	5250	5398	5552	5712	5871	6055	30
31	14	42	74	11	53	5401	54	15	82	58	31
32	16	44	76	13	55	03	57	17	85	61	32
33	18	46	78	15	58	06	59	20	88	64	33
34	20	48	81	18	60	08	62	23	91	67	34
35	22	50	83	20	63	11	65	25	94	70	35
36	24	52	85	22	65	13	67	28	96	73	36
37	26	55	87	25	67	16	70	31	99	76	37
38	28	57	90	27	70	18	73	34	5902	79	38
39	4731	4859	4902	5129	5272	5421	5575	5736	5905	6082	39
40	4733	4861	4994	5132	5275	5423	5578	5739	5908	6085	40
41	35	63	96	34	77	26	80	42	11	88	41
42	37	65	99	36	80	28	83	45	14	91	42
43	39	68	5001	39	82	31	86	47	17	94	43
44	41	70	03	41	84	33	88	50	19	97	44
45	43	72	05	43	87	36	91	53	22	6100	45
46	45	74	08	46	89	38	94	56	25	03	46
47	47	76	10	48	92	41	96	58	28	06	47
48	50	79	12	51	94	43	99	61	31	09	48
49	4752	4881	5014	5153	5297	5446	5602	5764	5934	6112	49
50	4754	4883	5017	5155	5299	5448	5604	5767	5937	6115	50
51	56	85	19	58	5301	51	07	70	40	18	51
52	58	87	21	60	04	54	10	72	43	21	52
53	60	90	23	62	06	56	12	75	46	24	53
54	62	92	26	65	09	59	15	78	48	27	54
55	64	94	28	67	11	61	17	81	51	30	55
56	66	96	30	69	14	64	20	83	54	33	56
57	69	98	33	72	16	66	23	86	57	36	57
58	71	4901	35	74	19	69	25	89	60	40	58
59	4773	4903	5037	5176	5321	5471	5628	5792	5963	6143	59
M	Min.	Min.	Min	Min.	Min	Min	Min	Min.	Min	Min	M
	61	62	63	64	65	66	67	68	69	70	

M	71 min.	72 min.	73 min.	74 min.	75 min.	76 min.	77 min.	78 min.	79 min.	80 min.	M
0	6146	6335	6534	6746	7210	7210	7468	7745	8046	8375	0
1	49	38	38	49	14	14	72	49	51	81	1
2	52	41	41	53	18	18	76	54	56	87	2
3	55	45	45	57	22	22	8[illegible]	59	61	93	3
4	58	48	49	60	27	27	8[illegible]	64	67	98	4
5	61	51	52	64	31	31	90	69	72	8404	5
6	64	54	55	68	35	35	94	74	77	10	6
7	67	58	58	71	39	39	9[illegible]	78	83	16	7
8	70	61	62	75	43	43	7503	83	88	22	8
9	6173	6364	6565	6779	7247	7247	7507	7788	8093	8427	9
10	6177	6367	6569	6782	7252	7252	7512	7793	8099	8433	10
11	80	7	72	86	56	56	16	98	8104	39	11
12	8	74	76	90	60	60	21	7803	09	40	12
13	86	77	79	93	64	64	25	08	15	51	13
14	89	80	83	97	68	68	30	13	20	57	14
15	92	84	8[illegible]	6801	73	73	35	17	25	63	15
16	95	87	90	04	77	77	39	22	31	69	16
17	98	90	93	08	81	81	44	27	36	74	17
18	6201	94	97	12	85	85	48	32	41	80	18
19	6205	6397	6600	6815	7289	7289	7553	7837	8147	8486	19
20	6208	6400	6603	6819	7294	7294	7557	7842	8152	8492	20
21	11	03	07	23	98	98	62	47	58	98	21
22	14	07	10	26	7302	7302	66	52	63	8504	22
23	17	10	14	30	06	06	71	57	68	10	23
24	20	13	17	34	11	11	76	62	74	16	24
25	23	17	21	38	15	15	80	67	79	22	25
26	26	20	24	41	19	19	85	72	85	28	26
27	30	23	28	45	23	23	89	77	90	34	27
28	33	27	31	49	28	28	94	82	96	40	28
29	6236	6430	6635	6853	7232	7332	7599	7887	8201	8546	29
M	min.	min.	min.	min.	min.	min.	min.	min.	min.	min.	M
	71	72	73	74	75	76	77	78	79	80	

M	71	72	73	74	75	76	77	78	79	80	M
	Min.	Min.	Min.	Min.	Min	Min	Min	Min	Min	Min	
30	6230	6433	6639	6856	7088	7336	7603	7892	8207	8551	30
31	42	37	42	60	92	41	08	97	12	58	31
32	45	40	46	64	96	45	14	7902	18	65	32
33	49	43	49	68	7100	49	17	07	23	71	33
34	52	47	53	71	04	53	22	12	29	77	34
35	55	50	56	75	08	58	26	17	34	83	35
36	58	53	60	79	12	62	31	22	40	89	36
37	61	57	63	83	16	66	36	27	45	95	37
38	64	60	67	86	20	71	40	32	51	8601	38
39	6268	6465	6670	6890	7124	7375	7645	7937	8256	8607	39
40	6271	6467	6674	6894	7128	7379	7650	7942	8262	8614	40
41	74	70	77	98	32	84	54	46	67	20	41
42	77	73	81	6902	36	88	59	53	73	26	42
43	80	77	85	05	40	92	64	58	79	32	43
44	83	80	88	09	45	97	68	63	84	38	44
45	87	83	92	13	49	7401	73	68	90	49	45
46	90	87	95	17	53	06	78	73	95	51	46
47	93	90	99	20	57	10	83	78	8301	57	47
48	96	94	6702	24	61	14	87	83	07	63	48
49	6299	6497	06	6928	7163	7419	7692	7989	12	8669	49
50	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	50
51	06	04	13	36	73	27	7702	99	24	82	51
52	09	07	17	40	77	32	06	8004	29	88	52
53	12	11	20	43	81	36	11	09	35	95	53
54	15	14	24	47	85	41	16	14	41	8701	54
55	19	17	28	51	89	45	21	20	47	07	55
56	22	21	31	55	94	49	25	25	52	14	56
57	25	24	35	59	98	54	30	30	58	20	57
58	28	28	38	63	7202	58	35	35	64	26	58
59	6332	6531	6742	6966	7206	7461	7740	8044	8369	8733	59
M	Min.	Min.	Min	Min.	Min	Min	Min	Min.	Min	Min	M
	71	72	73	74	75	76	77	78	79	80	

By the help of the table of Meridional Parts, it will be eafy to give folutions to all the ufual cafes in Mercator Sailing, and thence to find the true bearing, diftance, difference of latitude and longitude, of any place propofed.

Problem 1ft. Let it be required to find the meridional parts for any given latitude?

The Rule, Find the degrees at the top of the Table, and the minutes in the firft or laft column, then is the column under the degree, and right againft the minutes you will have the meridional parts for that latitude.

M	81	82	83	84	85	86	87	88	89	M
	Min	Min	Min	Min	Min	Min	Min	Min	Min	
0	8739	9145	9606	10137	10765	11533	12522	13916	16300	0
1	43	53	14	147	776	547	541	945	357	1
2	52	60	22	157	788	561	561	974	416	2
3	58	67	31	166	799	576	580	1400	476	3
4	65	74	39	175	811	580	599	033	537	4
5	71	82	47	185	822	605	619	063	599	5
6	78	89	55	195	834	620	639	093	662	6
7	84	96	64	205	846	634	659	123	726	7
8	91	9203	9672	214	858	649	679	154	792	8
9	8797	9211	9680	10224	10869	11654	12699	14184	16858	9
10	8804	9218	9689	10234	10881	11679	12719	14216	16926	10
11	10	25	97	244	893	694	739	247	996	11
12	17	33	9706	254	905	709	759	279	17067	12
13	23	40	14	264	917	724	780	311	139	13
14	30	48	23	273	929	739	801	343	213	14
15	36	55	31	283	941	755	821	376	259	15
16	43	62	40	293	953	770	842	408	366	16
17	49	70	48	303	965	785	863	442	445	17
18	56	77	57	314	978	801	884	475	526	18
19	8863	9285	9705	10324	10990	11816	12906	14509	17609	19
20	8869	9292	9774	10334	11902	11832	12927	14543	17693	20
21	76	9300	83	344	014	848	949	578	781	21
22	83	07	91	354	027	863	970	613	870	22
23	89	10	9800	364	039	879	992	648	962	23
24	96	22	09	374	052	895	13014	684	18056	24
25	8903	31	17	385	064	911	036	720	153	25
26	09	37	26	395	077	927	059	756	252	26
27	16	45	35	405	089	943	082	793	355	27
28	23	53	9844	416	102	959	104	830	461	28
29	8930	9360	9852	10426	11115	11976	13126	14868	18570	29
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	81	82	83	64	85	66	87	88	89	

Example. Let it be required to find the Meridional Parts for the latitude 51 .17 either north or south.

Look at the top of the table for 51 degrees, and for 17 minutes in the first column, then against the minutes, and under 51 degrees, you will have 3596, the meridional parts required.

Problem 2d. To find the meridional difference of latitude between any two places.

Case 1st. If one place be under the equator and the other in north or south latitude, then the meridional parts answering to the latitude proposed, will be the meridional difference of latitude.

Example. If one place be under the equator, and the other in 40 .30 N, then the meridional difference of latitude will be found to be 2662.

M	81 Min	82 Min	83 Min	84 Min	85 Min	86 Min	87 Min	88 Min	89 Min	M
30	8936	8368	9861	10437	11127	11992	13149	14907	16682	30
31	43	76	70	447	140	12008	172	94	799	31
32	50	83	79	457	153	025	195	983	920	32
33	57	91	88	468	166	041	219	15022	19045	33
34	63	99	97	478	179	058	242	062	174	34
35	70	8407	9906	489	192	075	266	102	309	35
36	77	14	15	500	205	092	29	143	450	36
37	84	22	24	510	218	109	314	18	596	37
38	91	30	33	521	231	126	338	220	749	38
39	8998	8438	9942	10532	11244	12143	13362	15268	16904	39
40	9005	8445	9951	10542	11257	12160	13386	15311	20076	40
41	12	53	59	553	270	177	411	354	253	41
42	18	61	69	564	284	194	437	398	439	42
43	25	69	78	575	297	212	461	442	635	43
44	32	77	87	586	310	229	486	487	843	44
45	39	85	96	596	324	247	511	532	21065	45
46	46	93	10005	608	337	264	537	579	303	46
47	53	9501	10015	62	351	282	563	625	557	47
48	60	09	024	630	365	300	586	673	835	48
49	9067	17	033	10641	11378	12318	13615	15721	22152	49
50	9074	9525	10043	10652	11392	12336	13641	15770	22459	50
51	81	33	053	663	406	354	668	819	22821	51
52	85	41	061	674	420	373	695	869	23226	52
53	96	49	071	685	434	391	721	920	23685	53
54	9103	57	080	696	448	409	749	972	24215	54
55	10	65	089	708	462	428	756	16024	24842	55
56	17	73	099	719	476	447	804	072	25609	56
57	24	81	108	730	490	465	832	153	26598	57
58	31	89	118	742	504	484	860	187	27992	58
59	9138	9598	10127	10758	11518	12503	13888	16243	30176	59
M	Min	Min	Min	Min	Min	Min	Min	Min	Min	M
	81	82	83	84	85	86	87	88	89	

If the places proposed are on the same side of the equator, that is, if they are both in north or both in south latitude, then the difference of the meridional parts, of each latitude, will be the meridional difference of latitude.

Example. If one place be in the latitude of 13 ,00 and the other in the latitude 50 ,10 N. the meridional difference of latitude will be 2703, as under.

Latitude —— 50 ,10 —— Meridional Parts 3490
Latitude —— 13 ,00 —— Meridional Parts 787

By Subtracting the remains will be —— 2703
The meridional difference of latitude required.

LEAP YEARS,

1776, 1780, 1784, 1788, 1792,

Days	Jan. South,		Feb. South,		March South		April North		May North		June North		Days
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
1	23	03	17	09	07	16	04	50	15	19	22	10	1
2	22	57	16	52	06	53	05	13	15	37	22	18	2
3	22	51	16	35	06	30	05	36	15	54	22	25	3
4	22	45	16	17	06	07	05	59	16	11	22	32	4
5	22	39	15	59	05	44	06	22	16	28	22	39	5
6	22	35	15	41	05	21	06	44	16	45	22	45	6
7	22	26	15	23	04	58	07	08	17	02	22	51	7
8	22	18	15	04	04	34	07	30	17	18	22	56	8
9	22	10	14	45	04	11	07	52	17	34	23	01	9
10	22	01	14	25	03	47	08	14	17	30	23	06	10
11	21	52	14	05	03	24	08	36	18	05	23	10	11
12	21	42	13	45	03	00	08	58	18	20	23	13	12
13	21	36	13	25	02	37	09	20	18	35	23	17	13
14	21	23	13	05	02	13	09	42	18	49	23	20	14
15	21	11	12	45	01	49	10	03	19	03	23	23	15
16	21	00	12	24	01	25	10	24	19	17	23	25	16
17	20	48	12	03	01	01	10	45	19	31	23	27	17
18	20	36	11	42	00	38	11	06	19	44	23	28	18
19	20	23	11	21	00	14	11	27	19	57	23	29	19
20	20	10	10	59	N.	09	11	47	20	00	23	29	20
21	19	57	10	38	00	33	12	07	20	21	23	29	21
22	19	44	10	16	00	56	12	27	20	33	23	29	22
23	19	30	09	54	01	20	12	47	20	44	23	28	23
24	19	16	09	31	01	44	13	07	20	55	23	27	24
25	19	01	09	09	02	08	13	27	21	06	23	25	25
26	18	46	08	47	02	31	13	46	21	16	23	23	26
27	18	31	08	23	02	54	14	05	21	26	23	20	27
28	18	15	08	02	03	17	14	24	21	36	23	17	28
29	17	59	07	39	03	41	14	43	21	45	23	14	29
30	17	43			04	04	15	01	21	54	23	11	30
31	17	26			04	27			22	02			31

LEAP YEARS,

1776, 1780, 1784, 1788, 1792,

Days	July. North		August. North		Sept. North		Octob. South,		Nov. South,		Decem. South		Days
	D.	M.	D.	M.	D.	M,	D.	M.	D.	M.	D.	M.	
1	23	07	17	53	08	03	03	28	14	42	21	58	1
2	23	02	17	38	07	41	03	52	15	01	22	07	2
3	22	57	17	22	07	19	04	15	15	20		15	3
4		52	17	06	06	57	04	38	15	39		23	4
5		46	16	50	06	35	05	01	15	57		31	5
6		40	16	33	06	12	05	24	16	15		38	6
7		34	16	16	05	50	05	47	16	33		45	7
8		27	15	59	05	27	06	10	16	50		51	8
9		20	15	42	05	04	06	33	17	07		56	9
10		12	15	25	04	41	06	56	17	29	23	01	10
11	22	04	15	06	04	18	07	19	17	20	23	06	11
12	21	55	14	48	03	55	07	42	17	56	23	10	12
13	21	46	14	30	03	32	08	04	18	12	23	14	13
14	21	37	14	11	03	09	08	26	18	28	23	18	14
15	21	28	13	53	02	46	08	48	18	43	23	21	15
16	21	18	13	34	02	23	09	10	18	58	23	23	16
17	21	08	13	15	02	00	09	32	19	13	23	25	17
18	20	57	12	55	01	36	09	54	19	27	23	27	18
19	20	46	12	36	01	13	10	16	19	41	23	28	19
20	20	35	12	16	00	49	10	38	19	54	23	29	20
21	20	24	11	56	00	26	10	59	20	07	23	29	21
22	20	12	11	35	00	02	11	20	20	20	23	29	22
23	19	59	11	15	S.	21	11	41	20	32	23	28	23
24	19	46	10	54	00	44	12	02	20	44	23	26	24
25	19	33	10	33	01	08	12	23	20	56	23	24	25
26	19	20	10	12	01	31	12	44	21	08	23	22	26
27	19	06	09	51	01	55	13	04	21	19	23	20	27
28	18	52	09	30	02	18	13	24	21	30	23	17	28
29	18	38	09	09	02	41	13	44	21	40	23	13	29
30	18	23	08	47	03	05	14	04	21	49	23	09	30
31	18	08	08	25			14	23			23	04	31

First after LEAP YEAR,

1773, 1777, 1781, 1785, 1789, 1793

Days	Jan. South.		Feb. South		March South		April North.		May North.		June North.		Days
	D	M	D	M	D	M.	D.	M.	D.	M.	D	M.	
1	22	59	16	57	07	24	04	44	5	19	22	08	1
2		54	16	40	07	01	05	07	15	32		17	2
3		48	16	23	06	38	05	31	15	56		24	3
4		42	16	04	06	14	05	54	16	07		31	4
5		35	15	56	05	51	06	17	16	24		38	5
6		27	15	27	05	28	06	39	16	41		44	6
7		19	15	08	05	05	07	02	6	58		50	7
8		11	14	49	04	41	07	24	17	15		55	8
9		03	14	30	04	18	07	46	17	35	23	00	9
10	21	54	14	11	03	54	08	08	17	45	23	05	10
11	21	45	13	52	03	30	08	30	18	01	23	09	11
12	21	35	13	32	03	06	08	52	18	16	23	13	12
13	21	25	13	12	02	42	09	14	18	31	23	17	13
14	21	15	12	51	02	19	09	35	18	45	23	20	14
15	21	05	12	30	01	55	09	57	19	00	23	22	15
16	20	54	12	09	01	32	10	18	19	14	23	24	16
17	20	42	11	48	01	08	10	39	19	27	23	26	17
18	20	29	11	27	00	44	11	00	19	40	23	27	18
19	20	16	11	05	00	21	11	21	19	53	23	28	19
20	20	02	10	43	N	02	11	41	20	06		29	20
21	19	48	10	22	00	26	12	02	20	18	23	29	21
22	19	34	10	00	00	50	12	22	20	30	23	29	22
23	19	20	09	38	01	14	12	42	20	41	23	28	23
24	19	05	09	16	01	37	13	02	20	52	23	27	24
25	18	50	08	54	02	01	13	21	21	03	23	25	25
26	18	35	08	31	02	24	13	40	21	14	23	23	26
27	18	20	08	09	02	48	14	00	21	24	23	21	27
28	18	04	07	46	03	11	14	19	21	34	23	18	28
29	17	48			03	35	14	38	21	43	23	15	29
30	17	31			03	58	14	56	21	52	23	11	30
31	17	14			04	21			22	01			31

First after LEAP YEAR,

1773, 1777, 1781, 1785, 1789, 1789.

Days	July North		August North,		Sept. North.		Oct. South		Nov. South		Dec. South,		Days
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
1	23	07	17	58	08	09	03	23	14	37	21	53	1
2	23	03	17	43	07	47	03	46	14	56	22	04	2
3	22	59	17	27	07	25	04	09	15	15		13	3
4		51	17	11	07	03	04	32	15	34		21	4
5		48	16	55	06	41	04	55	15	52		29	5
6		42	16	38	06	19	05	18	16	10	22	35	6
7		35	16	21	05	56	05	41	16	23		42	7
8		28	16	04	05	33	06	03	16	45		49	8
9		21	15	47	05	10	06	27	17	02		55	9
10		14	15	29	04	47	06	49	17	19	22	00	10
11	22	06	15	11	04	25	07	12	17	36	23	05	11
12	21	58	14	53	04	01	07	35	17	52	23	10	12
13	21	49	14	35	03	38	07	58	18	08	23	14	13
14	21	40	14	17	03	15	08	20	18	24	23	17	14
15	21	31	13	58	02	52	08	42	18	39	23	20	15
16	21	21	13	39	02	29	09	04	18	54	23	23	16
17	21	11	13	20	02	06	09	26	19	09	23	25	17
18	21	00	13	00	01	43	09	48	19	24	23	27	18
19	20	49	12	41	01	20	10	10	19	38	23	28	19
20	20	38	12	21	00	56	10	32	19	51	23	29	20
21	20	27	12	01	00	33	10	54	20	04	23	29	21
22	20	15	11	41	00	09	11	15	20	17	23	29	22
23	20	03	11	21	S.	14	11	36	20	30	23	28	23
24	19	50	11	00	00	35	11	57	20	43	23	27	24
25	19	37	10	39	01	01	12	18	20	54	23	25	25
26	19	24	10	18	01	25	12	38	21	05	23	23	26
27	19	10	09	57	01	48	12	59	21	16	23	20	27
28	18	56	09	36	02	12	13	29	21	26	23	17	28
29	18	42	09	15	02	36	13	39	21	36	23	14	29
30	18	28	08	53	03	00	13	58	21	46	23	10	30
31	18	13	08	31			14	17			23	06	31

Second after LEAP YEAR,

1774, 1778, 1782, 1786, 1790, 1794.

Days	Jan. South.		Feb. South.		March. South,		April North,		May North,		June. North,		Days
	D.	M.	D.	M.	D.	M.	D.	M.	D,	M.	D,	M,	
1	23	02	17	01	07	28	04	39	15	09	22	06	1
2	22	56	16	44	07	05	05	02	15	27		14	2
3		50	16	26	06	42	05	25	15	45		22	3
4		43	16	08	06	19	05	48	16	03		29	4
5		36	15	50	05	56	06	11	16	20		30	5
6		29	15	32	05	33	06	33	16	37		42	6
7		21	15	13	05	10	06	56	16	53		48	7
8		13	14	54	04	46	07	18	17	09		54	8
9		05	14	35	04	23	07	41	17	25		59	9
10	21	56	14	15	03	59	08	03	17	41	23	04	10
11	21	47	13	56	03	36	08	25	17	57	23	08	11
12	21	37	13	36	03	12	08	47	18	12	23	12	12
13	21	27	13	16	02	49	09	09	18	27	23	15	13
14	21	16	13	55	02	25	09	30	18	42	23	18	14
15	21	05	12	34	02	01	09	52	18	56	23	29	15
16	20	54	12	13	01	37	10	13	19	10	23	23	16
17	20	42	11	52	01	14	10	34	19	24	23	25	17
18	20	30	11	31	00	50	10	55	19	37	23	27	18
19	20	18	11	10	00	26	11	16	19	50	23	28	19
20	20	05	10	49	00	02	11	37	20	03	23	29	20
21	19	51	10	27	N,	21	11	58	20	15	23	29	21
22	19	37	10	05	00	49	12	18	20	27	23	29	22
23	19	23	09	43	01	05	12	37	20	38	23	28	23
24	19	09	09	21	01	32	12	57	20	49	23	27	24
25	18	55	08	59	01	56	13	17	21	00	23	26	25
26	18	40	08	37	02	19	13	36	21	11	23	24	26
27	18	24	08	14	02	43	13	55	21	21	23	22	27
28	18	08	07	51	03	06	14	14	21	31	23	19	28
29	17	52			03	30	14	33	21	40	23	16	29
30	17	36			03	53	14	51	21	49	23	13	30
31	17	20			04	16			21	58			31

Second after LEAP YEAR,

1774, 1778, 1782, 1786, 1790, 1794

Days	July North,		August, North,		Sept. North,		Octob, South,		Nov, South.		Dec, South,		Days
	D.	M,	D.	M,	D,	M,	D,	M,	D,	M,	D,	M,	
1	23	09	18	01	08	14	03	16	14	32	21	53	1
2	23	04	17	46	07	52	03	39	14	51	22	02	2
3	22	59	17	30	07	30	04	01	15	10		11	3
4		54	17	14	07	08	04	26	15	29		19	4
5		49	16	58	06	46	04	49	15	47		27	5
6		43	16	42	06	24	05	12	16	05		34	6
7		37	16	25	06	01	05	35	16	23		41	7
8		30	16	08	05	38	05	58	16	41		47	8
9		23	15	51	05	16	06	21	16	58		53	9
10	22	16	15	33	04	53	06	44	17	15	22	59	10
11	22	08	15	16	04	30	07	07	17	32	23	04	11
12		00	4	58	04	07	07	30	17	48		09	12
13	21	51	14	40	03	34	07	53	18	04		13	13
14		42	14	21	03	21	08	15	18	20		16	14
15		33	14	02	02	58	08	37	18	35	23	19	15
16		23	13	43	02	35	08	59	18	50	23	22	16
17		13	13	23	02	11	09	21	19	05	23	24	17
18		03	13	05	01	47	09	43	19	20	23	26	18
19	20	52	12	45	01	24	10	05	19	34	23	27	19
20	20	41	12	25	01	01	10	27	19	48	23	28	20
21	20	29	12	05	00	38	10	48	20	01	23	29	21
22		17	11	45	00	14	11	09	20	14	23	29	22
23		05	11	25	S,	09	11	30	20	27	23	28	23
24	19	53	11	05	00	32	11	51	20	39	23	27	24
25	19	40	10	45	00	56	12	12	20	51	23	25	25
26	19	27	10	23	01	19	12	33	21	02	23	23	26
27	19	44	10	02	01	43	12	53	21	13	23	21	27
28	19	00	09	41	02	06	13	13	21	24	23	18	28
29	18	46	09	20	02	29	13	33	21	34	23	14	29
30	18	31	08	58	02	52	13	53	21	44	23	10	30
31	18	16	08	36			14	13			23	06	31

Third after LEAP YEAR,

1775, 1779, 1783, 1787, 1791, 1795.

Days	Jan.		Feb.		March		April		May.		June.		Days
	South		South		South.		North		North		North.		
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M	M.	D.	
1	23	02	17	05	07	31	07	4	15	05	22	0-	1
2	22	57	16	48	07	11	04	56	15	23		12	2
3		51	16	31	06	48	05	19	15	41		20	3
4		45	16	13	06	25	05	42	15	19		28	4
5		38	15	55	06	02	06	55	16	16		35	5
6		31	15	36	05	39	06	28	16	33		41	6
7		23	15	18	05	16	06	51	16	50		47	7
8		15	14	59	04	52	07	13	17	06		53	8
9		07	14	40	04	29	07	35	17	22		58	9
10	21	59	14	20	04	05	07	57	17	-	23	03	10
11	21	50	14	00	03	42	08	20	17	54	23	07	11
12	21	40	13	40	03	28	08	42	18	09		11	12
13	21	30	13	20	02	55	09	04	18	2-		14	13
14	21	19	13	00	02	31	09	2-	18	38		17	14
15	21	08	12	40	02	07	09	47	18	53		28	15
16	20	57	12	19	01	43	10	08	19	07		23	16
17	20	45	11	58	01	02	10	29	19	20		25	17
18	20	33	11	37	00	56	10	50	19	33		27	18
19	20	20	11	16	00	33	11	11	19	46		28	19
20	20	07	10	54	00	09	11	31	19	59	23	29	20
21	19	54	10	32	N,	14	11	52	20	12	23	2-	21
22	19	40	10	10	00	38	12	12		2-		29	22
23	19	26	09	48	01	02	12	33		36		28	23
24	19	12	09	26	01	26	12	52		47		27	24
25	18	58	09	04	01	58	13	12		58		26	25
26	18	43	08	42	02	13	13	31	21	09		2-	26
27	18	27	08	20	02	37	13	50		19		22	27
28	18	11	07	57	03	00	14	09		29		20	28
29	17	55			03	24	14	28		39		17	29
30	17	39			03	47	14	47		48	23	13	30
31	17	22			04	10			22	56			31

Third after LEAP YEAR,

1775, 1779, 1783, 1787, 1791, 1795,

Days	July. North.		August North.		Sept, North.		Octob. south.		Nov south.		Dec, south,		Days
	D,	M,	D,	M,	D,	M,	D	M,	D,	M,	D,	M,	
1	23	0	8	05	08	20	03	10	14	27	21	51	1
2		05	17	50	07	58	03	34		47	22	00	2
3		0		34	07	36	03	57	15	06		09	3
4	22	56		18	07	13	04	20		25		17	4
5		51		02	06	51	04	44		43		25	5
6		45	16	46	06	29	05	07	16	01		32	6
7		3		29	06	07	05	30		19		29	7
8		32		12	05	44	05	53		37		46	8
9		25	15	55	05	22	06	16		54		52	9
10		18		33	04	59	06	39	17	11		58	10
11	22	10	15	20	04	36	07	02	17	28	23	03	11
12		02		02	04	13	07	25		44		08	12
13	21	53	14	44	03	50	07	48	18	00		12	13
14		44		26	03	27	08	10		16		16	14
15		35		07	03	04	08	32		32		19	15
16		26	13	48	02	40	08	54		47		22	16
17		16		29	02	17	09	46	19	02		24	17
18		05		10	01	53	09	38		16		26	18
19	20	54	12	50	01	30	0	00		30		28	19
20		43		31	01	07	10	22		44	23	29	20
21	20	32	12	10	00	44	10	43	19	58	23	29	21
22		20	11	51	00	20	11	04	20	11		29	22
23		08		30	S,	03	11	25		24		28	23
24	19	56		09	00	26	11	46		36		27	24
25		43	10	49	00	50	12	07		48		26	25
26		30		28	01	13	12	28		59		24	26
27		17		07	01	37	12	49	21	10		22	27
28		0	09	46	02	00	13	09		21		19	28
29	18	49		25	02	23	13	29		31		16	29
30		35		04	02	46	13	49		41		12	30
31		20	08	42			14	08				08	31

A TABLE of the Latitude and Longitude of the principal Harbours, Headlands, Islands, in the World, corrected, by the latest and best Observations; the beginning of the said Longitudes being accounted from the Meridian of LONDON.

N. B. The Latitude and Longitude of any Island, mentioned in this Table, is meant of the middle thereof, except some part of it be expressed or named.

Names of Places.	Nor. Lat,	West Long
The Coast of England.	*D M,*	*D,M,*
BERWICK	55 50	01 44
Newcastle	55 14	01 30
Stockton	54 33	01 25
Shelles	52 02	01 30
Sunderland	54 52	01 20
Hartlepole	54 40	00 55
Whitby	54 35	00 40
Scarborough	54 20	00 03
Hull	53 43	00 28
	Nor, Lat,	East Lon,
Flamborough Head	54 08	00 11
Burlington	54 00	00 06
Spurn	54 35	00 43
Grimesby	53 39	00 56
Bofton	53 09	00 10
Lyn	52 56	00 29
Wells	53 07	01 00
Blackney	53 24	00 55
Cromer	53 15	01 07
Winterton	53 02	01 22
Yarmouth	52 40	01 40
Alborough	52 24	01 25
Orfordneſs	52 20	01 11

Names of Places,	Nor, Lat,	East Long
The Coast of England.	*D,M,*	*D,M,*
Ipſwich	52 14	01 00
Harwich	52 11	01 18
Colcheſter	52 04	00 58
LONDON	51 32	00 00
Rocheſter	51 28	00 25
Margate	51 23	01 10
North Foreland	51 28	01 10
Sandwich	51 27	01 09
The Downs	51 25	01 21
South Foreland	51 12	01 20
Ripraps	51 15	01 25
Dover	51 25	01 18
Dungeneſs	51 01	00 51
Rye	51 03	00 45
Beachy	50 48	00 25
	Nor, Lat.	West Long,
Shoreham	50 55	00 17
Portſmouth	50 48	01 00
Dunnoſe I. Whight	50 38	01 23
Pool	51 00	01 50
Weymouth	30 43	02 40
Portland	50 30	02 48
Chiddock	50 47	03 00

Lime

Names of Places.	Nor. Lat,	West Long
The Coaſt of England	D.M,	D,M,
Lime	50 45	03 14
Topſham	50 37	03 27
The Berry Head	50 23	03 49
Torbay	50 25	03 38
Dartmouth	50 27	03 36
Start Point	49 50	03 45
The Eddy ſtone	50 07	04 30
Plymouth	50 36	04 13
Ramhead	50 14	04 35
Foy	50 25	04 30
Falmouth	50 12	05 12
Lizard	49 55	05 14
St Mary Scilly	49 57	06 45
Lands End	50 06	06 00
Gulf	50 00	06 06
Seven ſtones	50 05	06 40
Hartland Point	51 06	04 35
Londey Iſle	51 20	04 40
Mort Bay	51 12	04 40
Swanſey	51 40	04 25
Briſtol	51 32	04 35
Caldey Iſland	51 33	05 14
Milford	51 45	05 15
ſt, David's Head	51 55	05 22
Barſky Iſle	52 40	05 10
Holy head	53 23	04 50
Weſt Cheſter	53 37	04 20
Lancaſter	54 40	03 35
Liverpool	53 20	03 10
Whitehaven	54 25	03 30
Iſle of Man W. end	53 45	05 00
Carliſle	54 47	03 05
Coaſt of SCOTLAND		
Glaſgow	55 53	04 05
North Part of ſhy I.	57 45	05 45
N. Part of Lewis iſle	58 20	07 20
ſt. Kilda	57 52	09 45
Sara head	58 39	05 10

Names of Places	Nor, Lat,	Weſt, Long
The Coaſt of Scotland.	D.M,	D,M,
N. part of Orkneys	59 13	03 22
Fair Iſle	59 30	03 20
Shetland ſouth point	60 04	02 00
Buckanneſs	57 45	01 13
Aberdeen	57 24	01 37
Dundee	56 28	02 36
Edinburgh	55 57	02 46
Leith	56 00	02 55
The Coaſt of Ireland		
Fair Foreland	55 05	06 30
London Derry	54 55	08 00
Belfaſt	54 36	06 50
Iſland Torre	55 0?	08 30
Iſle of Arran	54 48	08 59
Stags of bro. Haver.	54 07	10 05
Sline head	53 20	11 15
Galloway	53 05	09 20
Gally or Doens Hd.	52 40	09 30
Lupis's Head	52 24	10 15
Limerick	52 22	09 48
Blaſques	52 00	11 55
Skillocks	51 20	11 55
Cow and calf	51 22	10 36
Mizon head	51 15	11 30
Old Head Kinſale	51 35	08 58
Cape clear	51 10	10 30
Cork	51 49	09 30
Waterford	52 07	07 52
Wexford	52 13	07 16
Lambay	53 24	07 36
DUBLIN	53 20	07 06
Coaſt of Holland and Flanders		Eaſt. Long
Helighland	54 28	8 35
Scaw	57 26	10 10
Hamborough	53 41	10 24

Names of Places	Nor. Lat.	East. Long
Coast of Holland and Flanders	*D.M.*	*D.M,*
Bremen	53 50	08 00
Emden	53 05	08 00
Ameyland	53 40	06 40
shelling	53 25	05 50
The Fly	53 18	05 35
The Texel	53 10	04 59
Amsterdam	52 21	04 51
Roterdam	51 55	04 21
Antwerp	51 17	04 32
The Brill	51 56	04 10
Middleburgh	51 48	04 00
sluys	51 19	03 50
Ostend	51 30	03 05
Dunkirk	51 18	02 25
Calis	50 57	02 00
Diep in France	49 56	01 06
Coast of France and Portugal		West. Long
cape de Hague	49 46	02 06
caskets	49 50	02 32
Guernsey	49 36	02 40
Jersey	49 20	02 19
St. Maloes	48 35	01 05
Morlaix	48 37	03 50
Ushant	48 30	02 05
Brest	48 23	04 24
Penmark	47 48	04 15
Bell Isle	47 20	03 10
Nants	47 14	01 49
Rochel	46 10	01 14
Bourdeaux	44 50	00 24
Bilboa	43 30	03 00
cape Ortegel	44 02	07 40
cape Coruna	43 28	09 20
cape Finister	43 06	10 00
Porta Port	41 18	09 20
Burlings	39 39	10 15
Rocks of Lisbon	48 54	10 20
cape St. Vincent	37 00	09 32

Names of Places	Nor, Lat	East. Lon.
Coast of France and Portugal.	*D.M,*	*D,M,*
cape St. Maria	36 58	09 18
Cadiz	36 16	07 00
cape Trefalgar	36 05	06 30
Coast on the Main Continent within the Straits.		
Gibraltar	36 11	05 05
Malaga	36 56	04 07
cape de Gat	37 03	02 06
cape Paul	37 58	0 22
cape Martin	39 00	0 28
Alicant	38 30	0 35
Barcelona	41 30	02 21
Toulon	43 06	05 40
Genoa	44 25	08 40
Leghorne	43 18	10 29
Civita Vecchia	41 46	12 00
Rome	41 51	12 28
Naples	41 05	14 28
cape Sparta-vento	38 00	16 58
cape Collone	32 10	18 00
Gallipoli	40 08	18 39
cape St. Mary	39 56	19 00
Ancona	43 31	14 40
Venice	45 18	13 10
Lepanto	38 20	21 55
cape Matapan	36 35	22 20
cape St. Angelo	36 41	23 20
Athens	38 00	24 29
cape Martelo S.P. of Negropont	38 00	25 45
cape Monte sancto	40 05	26 05
Gallipoli	40 30	27 58
Constantinople	41 07	31 00
Smyrna	38 30	27 25
Ephesus	37 54	27 15
Antiochetta	36 40	31 37
scanderoon	36 00	35 58
Tripoli	34 40	35 40

Alexandria

Names of Places,	Nort, Lati.	East Lon,
Coast of the main continent in Straits.	*D,M,*	*D,M,*
Alexandria	31 07	30 50
cape Rusfato	33 15	21 55
cape Mitorato	32 43	16 23
cape Bona	37 05	10 00
Bona	37 00	07 00
Algier	36 40	03 05
cape de tres forces	35 31	01 25w.
Tetuan	35 28	05 52w.
Ceuta	35 55	05 47w
Tangier	35 55	06 14w.
Orun	35 46	00 26w.
Islands within the Straits		
Alborn	36 10	1.0w.
Formentaria	38 44	01 31
Yvica	39 05	01 30
Majorca city	39 48	02 49
Minorca P. Mahon	40 02	04 25
S. end of Sardinia	38 46	09 10
N. end of Sardinia	41 00	10 01
N. end of Corsica	42 56	09 50
Gorgona	43 34	09 38
Capita	43 05	14 54
Lilboa	42 45	11 00
Messina	35 07	16 20
Maritimo	35 12	17 09
cape Passero	36 38	15 40
Malta	35 53	14 32
Corfu	39 42	20 06
Zepholonia	38 15	21 00
Zant	37 46	21 14
Morea	36 52	21 32
Limnos	39 59	25 37
Scio	38 22	26 12
cape st. John w. end Candea	35 15	24 00
cape Soleman E. end of Candea	35 00	27 08
city of Rhodes	36 42	28 05

Names of Places.	Nor, Lat.	East Lon,
Islands in the *Straits*	*D,M,*	*D,M,*
West end of Cyprus	34 57	32 23
East end of ditto	35 37	25 00
		West, Long
The coast of *Barbary* and *Guiney*		
cape Spartel	35 50	05 44
Sallee	38 51	06 25
cape Cantin	32 26	09 10
cape de Geer	30 27	10 06
cape Bajadore	26 04	15 30
cape Otrado	13 41	15 50
cape Blanco	20 42	17 35
Senegal	15 28	16 25
cape de Verd	14 47	17 30
River Gambia	13 08	5 31
Scorrabor	08 36	12 57
cape Monte	06 23	10 45
cape Monterado	06 05	10 02
cape Palmos	04 13	06 45
River Ester	05 25	05 13
Jaque Jaque	04 16	02 47
River st. Andrew	05 00	03 15
Assene	04 15	02 17
cape three Points	04 28	01 50
		East Long
River Volta	05 55	03 25
River Formosa	07 50	07 20
cape Formosa	04 15	06 40
New Calibar	04 42	08 33
Old ditto	04 10	09 45
Ments River	03 10	10 08
River Camerones	03 25	10 10
River Angra	00 15	15 25
	Sou, Lat,	
cape Lopez	00 59	09 55
Iland Gabees	00 40	11 30
River Congo	05 40	15 25

Names of Places	Nort. Lat	West. Long
Coast of Barbary and Guiney	*D,M,*	*D,M,*
Angola	08 57	15 56
cape Negro	16 08	12 31
cape st. Thomas	24 10	14 43
Secos	28 56	15 30
cape of Good Hope	34 07	19 35
Weſtern Iſlands		
Corvo	39 34	30 50
Flores	39 32	30 54
Fial	38 53	28 15
Pico	38 40	27 20
st. George	38 52	26 03
Tercera	38 57	25 24
st. Michael	38 06	23 26
st. Maries	26 59	23 38
Gratioſa	39 30	38 15
Canary Iſles		
Ferro	27 54	17 45
Palma	28 40	17 56
Gomera	28 06	17 05
Teneriff	28 23	16 28
Madiera W. end	32 44	17 26
Porto ſancto	33 12	15 54
Canaries	27 52	15 10
Fortaventura	28 05	23 30
Lancerota	29 02	12 45
The cape de Verd Iſlands		
st, Antonia	17 55	24 40
st. Vincent	17 04	14 39
st. Lucia	17 00	24 30
st. Nicholas	16 50	23 48
Brava	14 28	24 02
Fuego	14 50	23 11
st. Jago	15 08	22 56
Iſle of May	15 14	22 02
Iſle de Sal	16 50	22 08

Names of Paces	ſouth Lat.	Weſt. Long
Southern Iſles	*M D,*	*D,M,*
Bonaviſta	16 05	22 07
st. Mathews	01 30	04 01
Aſcenſion	08 07	14 15
st. Helena	16 16	05 14
	Nor. Lat.	Eaſt. Long
Farnandepo	02 40	09 15
Princeps	01 40	08 20
st. Thomas	00 00	08 20
Annabona	02 10	07 27
Coaſt of the Main continent in the *Eaſt Indies.*	ſouth Lat.	
cape Lagullas	34 06	18 35
River st. Lucia	34 55	21 20
cape Corientes	23 42	36 15
Moſambique	15 05	41 10
cape Falſo	09 00	39 19
Tangon	04 50	39 07
Mombaſo	03 55	38 30
Molinde	03 00	39 40
River Lamas	01 20	40 13
River Fugos	00 00	42 05
	Nort. Lat.	
Magades	02 21	44 50
cape Baſſos	04 15	47 58
cape Guardaſoy	11 50	51 20
cape Roſulgat	22 41	59 45
capeMuca or Muſcat	23 36	57 40
Buſſera	29 50	49 05
Gamberoon	27 30	56 36
Surrat	21 08	72 25
Goa	18 32	73 50
Calcuta	11 17	78 34
Cochin	09 58	76 05
cape Comarino	07 50	78 15
Columba in Zeloan	07 07	79 35
Fort st. George	13 08	80 42
Dew Point	15 59	81 25

Viſegapatum

Names of Places	Nort. Lat.	East, Long
The Coaſt of Main continent in the *Eaſt Indies.*	D,M,	D,M,
Viſegrapatam	17 40	84 07
Pondey	18 45	85 30
cape Palmiris	20 45	88 10
Ballaſora	21 10	87 50
Piply	21 25	87 58
Bengal	22 17	92 29
cape Nigrais	16 23	93 25
Malacca	02 12	102 10
Formſa	07 55	101 40
Siam entrance	13 10	101 01
Cambodia entrance	14 05	108 00
cape Avarille	13 20	108 00
Cochim chimchon	14 05	107 58
Cantam	23 08	113 08
Amay or Quemay	24 25	116 55
Lampo	30 10	120 25
Ille chuſan	30 05	120 35
Namquin	33 15	120 05
Iſlands in the Eaſt-Indies		
Madagaſcar, or ſt. Lawrence S. E.	25 47	46 10
North End	12 10	50 30
ſt. John de Leſbon	25 24	53 30
Mayetta	12 18	49 49
Mehilla	12 05	43 41
Comero	11 50	52 55
ſt. Juan de nova	17 30	43 05
Mauritius	20 05	52 55
Digo Royes	15 45	61 35
Rominas de caſtelamos	29 00	67 16
Amſterdam	38 50	74 24
ſt. Brandon	16 38	64 30
Digo gratioſa	08 42	68 25
Quabella	03 49	52 39
Baſſoſde chagos	06 45	70 24
Vas de Digo Rays	00 10	72 05

Names of Places	ſouth. Lat.	East. Long.
Iſlands in the Eaſt-Indies	D,M,	M,D,
Maldivia *N.* end	07 15	73 05
Maldivia S. end	00 40	76 15
Malique	09 00	73 05
Saccatra	12 21	54 07
Abdaleur	12 09	53 03
cape Gallo in Zeloan	06 0-	80 45
	North Lat.	
Yes de Amber	00 00	52 30
Andyman the mid.	12 40	93 19
Nicobar	07 05	93 45
Sumatra N. W. End	05 25	94 45
Engano	05 50	102 13
Virkins Iſle	02 2-	95 07
	ſouth-Lat.	
Naſſau Iſlands	02 54	98 32
Bencola	03 50	101 13
Sumatra S. E. End	05 22	104 14
Selam	08 22	104 02
Princes Iſle	06 30	105 55
Bantam in Java	06 11	106 37
Batavia	06 16	112 27
Java Eaſt end	08 35	104 18
Straits of ſundy	03 25	106 37
Banca ſouth end	04 14	112 52
Borneo ſouth point	04 04	126 37
Celebes ſouth end	05 40	119 07
Celebes N. end	01 40	121 00
	North Lat.	
Mindano W. poin.	06 40	118 35
Bornea N. point	07 10	112 55
Luconia S. point	12 30	120 50
Luconia N. E. p	18 39	119 45
Arain W. point	19 30	108 06
Arain eaſt point	19 50	111 16
Formoſa S. point	22 00	119 56
Formoſa N. poin	25 32	120 25

Piſcadora

Names of Places	north latit,	East, longi.
East India Iſlands	*D, M*	*D, M,*
Piſcadora	43 30	117 35
Iſland Chuſan	30 28	120 35
Japan s.e. point	35 30	140 30
Japan s.w. point	35 00	128 30
Coaſt of America in the South Sea, from California to C H.		Weſt. longi.
cape ſt. Sebaſtian	42 45	129 55
cape ſt. Luca	23 20	111 46
cape corrientes	9 40	110 30
Acapulco	17 00	106 03
Aquatulco	15 27	103 03
Guatimala	14 25	96 00
Panama	08 56	82 18
Bay Bonaventura	03 28	80 06
Iſles of Gallopego	00 00	90 20
	ſouth latit	
cape del Ajugo	00 30	88 50
Lima	12 30	73 30
Arica	18 17	73 10
la ſerena	24 32	76 32
I. Juan or Fernando	23 20	86 48
Baldivia	39 35	81 20
Port Steven	46 50	82 36
cape Victory	52 15	83 20
cape Horn	57 58	79 55
Coaſt of Brazil in South America		
Magellan, Entrance	51 58	75 30
River Julian	48 40	74 32
cape Blanco, near river camarones	46 50	72 10
Buenas Ares or river Plata	35 40	58 00
River Grand	31 55	51 50
ſt. Katherine's Iſle	28 00	48 50
cape Frio	22 55	42 26

Names of Places	ſouth latit.	Weſt. longi.
Coaſt of Brazil in ſouth America,	*M, D.*	*D, M,*
Spirito ſancto	19 58	42 00
P. Segura	16 12	38 50
Bay Todus Sanctus	12 50	40 36
River ſt. Franciſco	10 55	37 40
cape ſt. Auguſtine	08 05	35 42
cape Roque	05 00	35 40
Friſtan de Cunha	37 05	25 38
Trinidada	25 30	30 00
Coaſt on the Main Continent in the Weſt Indies	north latit.	
River Amazones en.	00 00	49 20
North cape	02 05	49 25
Surnam	06 25	55 35
Oroonoque	08 15	39 25
cape Cequibaca	12 48	70 40
Carthagena	10 28	75 20
Scotch ſettlement	18 30	78 45
Nicaraque Entr.	11 25	84 00
cape Catocha	21 10	86 15
Campeche	19 30	92 00
La vera cruz	19 10	97 35
cape Florida	24 58	80 35
Eſcondide	18 20	99 00
Miſſiſippi R. mouth	28 30	96 00
Apalachia	29 47	88 48
The Caribbes, or Weſt India iſlands		
Trinidada	10 15	60 12
Tobago, weſt end	11 10	59 10
Granada	11 57	60 20
Barbadoes	12 58	58 20
ſt. Vincent	13 12	60 12
ſt. Lucia	13 55	60 04
Martinico	14 43	60 54
Dominico	15 2	60 30
Marigallante	15 58	60 20
Guardalupe		

Names of Places	north latit,	West. long,
Caribees, or West-India Islands,	D.M.	D.M.
Guardulupa	16 10	61 15
Montserat	6 45	62 15
Antegoa	17 05	61 45
Nevis	17 05	62 32
st. Christophers	17 17	62 40
Barbuda	17 56	60 40
st Bartholomew	17 52	62 06
st. Martin's	18 06	62 10
Anguella	18 17	62 13
Virgins	18 30	63 25
st. Cruz	17 52	63 30
Bieque	18 09	63 15
Port Rico or st. John	18 30	65 37
st. Dominica Hyspaniola	18 25	69 30
P. Royal Jamaica	17 40	76 52
East end of Cuba	20 15	73 55
Havanna	22 49	82 55
Bay Honda	22 45	83 40
cape st. Antonia	21 45	85 32
st. Thomas	18 30	00 22
Barmudas	32 25	63 40
N. Point of Bahama Banks	28 00	78 35
Bahama Island	26 50	79 30
Abbacco south point	26 00	73 46
Harbour Island	25 37	76 47
Androfs N. point	25 10	78 39
Providence	23 00	77 20
Illathera south Poi,	24 40	75 56
cat Island	24 25	75 09
Watling Island	24 07	74 30
Rum Key	23 45	74 50
Exuma	23 22	75 55
crooked Isle N, pt,	22 56	74 12
Atkin's Key	22 17	74 05
Metapervouz	21 58	74 45
Atwood's Keys	23 18	73 35
French Keys	22 40	73 40
Mayaguana	23 35	72 46
Hogsties	21 17	73 55

Names of Places	north Lat,	West, long,
Bahama Islands	D.M.	D.M.
Hyneago	20 52	73 46
concos Bank N. Pt,	21 50	71 15
Turks Island	21 35	71 06
Abrolbo, N. point	21 35	69 06
Plate Wreck	20 10	68 15
Coast of carolina, Virginia, Maryland Pensylvania, New England, New Foundland.		
charles Town upon Afsiby-river.	32 45	78 46
cape Hatteras	35 17	74 20
cape Henry	37 00	75 02
cape charles	37 16	74 16
cape Hinlopen	38 50	74 56
Long Island	40 50	72 45
New York	40 58	73 33
cape Cod	42 12	68 55
Boston	42 30	69 23
cape Sable	43 50	64 58
Island Sable	44 29	59 07
cape Britain	46 00	58 30
Queebeck	46 55	70 48
Bay of Breft	52 10	56 57
Bell Island	52 07	55 55
cape st. John	50 18	52 48
Penguin Island	50 15	53 10
cape Bonavista	49 55	52 12
Trinity bay, entr.	48 42	52 20
Conception bay	48 20	52 08
st. John Harbour	48 00	51 30
Bay of Bulls	47 50	51 29
cape Race	46 40	51 52
cape st. Mary	47 10	53 23
Placentia	47 45	53 58
cape Roy	48 00	57 40

coast

Names of Places.	north Lat.	West Long
The coast of Hudson's Bay and straits	D,M,	D,M,
Buttons Isle	00 25	66 27
cape charles	62 10	75 35
cape Welfingham	62 35	77 55
Mansfield Isle	61 42	80 30
cape Jones	54 55	78 58
Robert's River	51 30	79 26
The cubbs	54 10	82 40
Albany River	52 26	84 50
c. Henrietta Maria	55 07	84 30
Port Nelson	57 10	93 58
cape churchill	59 00	95 20
cape Southampton	61 55	86 48
Shark point	64 30	82 55
Nottingham Isle	63 30	79 53
Q. Anne's Foreland	63 43	74 45
Resolution Isle	61 50	65 04
cape Farewell	59 45	46 45
The coast of Iceland Greenland Nova Zembla, and the northern isles		
Sound Royal	66 22	14 33
Bargazar point	66 20	6 33
Whales back	65 29	20 33
Merchants Foreland	63 25	17 08
Hallisord	64 30	34 43
Fair Foreland	66 20	16 27
Grims Isles	67 15	22 34
Westuevecia Isles	63 30	22 34
Isles of Terre	62 06	05 00
		East. Long
Brimberg or John Mam's Isle	71 45	04 30
Point Lookout	76 25	15 36
Horn sound	76 45	13 36
Fair foreland	79 21	10 52
Halcuta foreland	79 55	11 00
Hellies sound	78 11	21 50

Names of Places	Nort. Lat.	West. Long
Greenland Isles &c.	D,M,	D,M,
Lees Foreland	78 05	23 25
Whales head	77 18	21 30
Hope Isle	76 18	23 48
cherry or Beer Isle	74 30	18 08
Admerallity Isle	75 05	54 50
Freiumborough	70 10	61 20
cape candy Nose	69 05	42 35
catnefs	65 43	35 15
Archangel Bar	64 30	40 30
crofs island	66 31	36 35
Seveft nofe	68 10	34 45
Keldurm	69 35	31 20
North cape	71 23	23 02
Surroy	71 05	16 40
Rum sound	70 25	15 30
Lofert, s. w. point	68 15	09 39
Dronton	63 50	10 15
Stadland	62 10	04 30
north Bergen	60 10	05 40
Naze of Norway	57 45	07 29
Sea coast in the Sound and Baltick		East Lon,
Maerden	58 19	08 57
Laerwick	58 54	09 20
chriftiana	59 20	10 00
Maefterland	57 53	11 45
Gotenburgh	57 50	12 15
Elfinore	56 22	12 42
Copenhagen	55 41	12 50
Valfterborn	55 28	13 00
Kalmer	56 40	16 35
Stockholm	59 20	19 30
Vyburgh	60 52	29 16
Peterfburgh	60 00	30 25
Narve	59 17	28 25
Revel	59 25	24 51
Riga	57 04	25 15
Derwinda	57 15	22 00
Kenningfberg	54 43	21 35
Dantzick	54 22	18 30
Wifbuy in Gotland	57 10	18 36

Bornholm

A TABLE of LOGARITHMS,

For Numbers increasing in their Natural Order, from an Unit to 4000.

With a Table of Natural and Logarithmic Sines and Tangents, to every Degree and two Minutes of the Quadrant, the Radius being 10,00000.

Num.	Logar.	Numb	Logar.	Numb.	Logar.
1	0,00000	34	1,53147	67	1,82607
2	0,30103	35	1,54406	68	1,83250
3	0,47712	36	1,55630	69	1,83884
4	0,60206	37	1,56820	70	1,84509
5	0,69897	38	1,57978	71	1,85125
6	0,77815	39	1,59106	72	1,85733
7	0,84509	40	1,60206	73	1,86332
8	0,90309	41	1,61278	74	1,8692
9	0,95424	42	1,62324	75	1,87506
10	1,00000	43	1,63346	76	1,88081
11	1,04139	44	1,64345	77	1,88649
12	1,07918	45	1,65321	78	1,89207
13	1,11394	46	1,66275	79	1,89762
14	1,14612	47	1,67209	80	1,90309
15	1,17609	48	1,68124	81	1,90848
16	1,20412	49	1,69019	82	1,91381
17	1,23044	50	1,69897	83	1,91907
18	1,25527	51	1,70757	84	1,92427
19	1,27875	52	1,71600	85	1,92941
20	1,30103	53	1,72427	86	1,93449
21	1,32221	54	1,73239	87	1,93951
22	1,34242	55	1,74036	88	1,94448
23	1,36172	56	1,74818	89	1,9493
24	1,38021	57	1,75587	90	1,95424
25	1,39764	58	1,76342	91	1,95904
26	1,41497	59	1,77085	92	1,96378
27	1,43136	60	1,77815	93	1,96848
28	1,44715	61	1,78533	94	1,97312
29	1,46239	62	1,79239	95	1,97772
30	[illegible]	[illegible]	[illegible]	96	1,98227
31	1,49136	64	1,80618	97	1,98677
32	1,50515	65	1,81291	98	1,99122
33	1,51851	66	1,81954	99	1,99562

No.	0	1	2	3	4	Differ.
100	2,00000	2,00043	2,00086	2,00130	2,00173	43
101	2 00432	2 00475	2 00518	2 00560	2 00603	42
102	2 00860	2 00902	2 00945	2 00987	2 01369	42
103	2 01283	2 01325	2 01368	2 01410	2 01452	41
104	2 01703	2 01745	2 01786	2 01828	2 01870	41
105	2 02118	2 02160	2 02201	2 02242	2 02284	41
106	2 02530	2 02571	2 02612	2 02653	2 02694	40
107	2 02938	2 02978	2 03019	2 03060	2 03100	40
108	2 03342	2 03382	2 03422	2 03462	2 03502	40
109	2 03742	2 03782	2 03822	2 03862	2 03901	39
110	2,04139	2,04178	2,04216	2,04257	2,04296	39
111	2,04522	2,04571	2,04610	2,04649	2,04688	38
112	2 04921	2,04960	2 04999	2,05038	2,05076	38
113	2 05307	2 05346	2 05384	2 05423	2 05461	38
114	2 05690	2 05728	2 05766	2 05804	2 05842	37
115	2 06069	2 06107	2 06145	2 06182	2 06220	37
116	2 06445	2 06483	2 06520	2 06558	2 06594	37
117	2 06818	2 06855	2 06892	2 06929	2 06966	36
118	2 07188	2 07225	2 07261	2 07298	2 07335	36
119	2 07554	2 07591	2 07627	2 07664	2 07700	36
120	2 07918	2 07954	2 07990	2 08026	2 08062	36
121	2,08278	2 08314	2 08350	2 08386	2 08421	35
122	2,08636	2,08671	2,08707	2,08742	2,08778	35
123	2,08990	2,09025	2,09061	2,09096	2,09131	35
124	2 09342	2 09377	2 09412	2 09447	2 09482	34
125	2 09691	2 09725	2 09760	2 09795	2 09829	34
126	2 10037	2 10071	2 10105	2 10140	2 10174	34
127	2 10380	2 10414	2 10448	2 10482	2 10516	34
128	2 10721	2 10754	2 10788	2 10822	2 10856	33
129	2 11059	2 11092	2 11126	2 11159	2 11193	33
130	2 11394	2 11427	2 11461	2 11494	2 11527	33
131	2 11727	2 11760	2 11793	2 11826	2 11859	33
132	2 12057	2 12090	2 12123	2 12156	2 12188	32
133	2,12385	2,12417	2,12450	2,12483	2,12515	32
134	2,12710	2,12742	2,12775	2,12807	2,12839	32
135	2,13033	2,13065	2,13097	2,13129	2,13161	32
136	2 13353	2 13385	2 13417	2 13449	2 13481	31
137	2 13672	2 13703	2 13735	2 13767	2 13798	31
138	2 13987	2 14019	2 14050	2 14082	2 14113	31
139	2 14301	2 14332	2 14363	2 14395	2 14426	31
140	2 14612	2 14643	2 14674	2 14705	2 14736	30
141	2 14921	2 14952	2 14983	2 15014	2 15044	30
142	2 15228	2 15259	2 15290	2 15320	2 15351	30
143	2 15533	2 15564	2 15594	2 15624	2 15654	29
144	2 15836	2 15866	2 15896	2 15926	2 15956	29
145	2,16136	2,16166	2,16196	2,16226	2,16256	29

No.	5	6	7	8	9	Differ
100	2,00210	2,00259	2,00302	2,00346	2,00389	43
101	2 00646	2 00689	2 00732	2 00774	2 00817	42
102	2 01072	2 01114	2 01157	2 01199	2 01241	42
103	2 01494	2 01536	2 01577	2 01619	2 01661	41
104	2 01911	2 01953	2 01994	2 02036	2 02077	41
105	2 02325	2 02366	2 02407	2 02448	2 02489	41
106	2 02735	2 02775	2 02016	2 02857	2 02897	40
107	2 03140	2 03181	2 03221	2 03261	2 03302	40
108	2 03543	2 03583	2 03622	2 03662	2 03702	40
109	2 03941	2 03981	2 04020	2 04060	2 04099	39
110	2,04330	2,04375	2,04414	2,04454	2,04493	39
111	2,04727	2,04766	2,04805	2,04844	2,04883	38
112	2,05115	2,05153	2,05192	2,05230	2,05269	38
113	2 05499	2 05537	2 05576	2 05614	2 05652	38
114	2 05880	2 05918	2 05956	2 05994	2 06032	37
115	2 06250	2 06295	2 06333	2 06370	2 06408	37
116	2 06632	2 06669	2 06707	2 06744	2 06781	37
117	2 07003	2 07040	2 07077	2 07004	2 07151	36
118	2 07371	2 07408	2 07445	2 07481	2 07518	36
119	2 07736	2 07773	2 07809	2 07845	2 07881	36
120	2 08098	2 08134	2 08170	2 08206	2 08248	36
121	2 08457	2 08581	2 08529	2 08564	2 08600	35
122	2,08813	2,08849	2,08884	2,08919	2,08955	35
123	2,09166	2,09201	2,09237	2,09272	2,09307	35
124	2 09516	2 09551	2 09586	2 09621	2 09656	34
125	2 09864	2 09899	2 09933	2 09968	2 10002	34
126	2 10209	2 10243	2 10277	2 10311	2 10346	34
127	2 10551	2 10585	2 10619	2 10653	2 10687	34
128	2 10890	2 10924	2 10957	2 10911	2 11025	33
129	2 11227	2 11260	2 11294	2 11294	2 11360	33
130	2 11561	2 11594	2 11628	2 11627	2 11694	33
131	2 11892	2 11925	2 11958	2 11991	2 12024	33
132	2 12221	2 12254	2,12287	2 12319	2 12352	32
133	2,12548	2,12580	2,12613	2,12645	2,12678	32
134	2,12872	2,12904	2,12936	2,12969	2,1300	32
135	2,13193	2,13226	2,13258	2,13290	2,13321	32
136	2 13513	2 13545	2 13576	2 13608	2 13640	31
137	2 13830	2 13861	2 13893	2 13924	2 13956	31
138	2 14145	2 14176	2 14267	2 14238	2 14270	31
139	2 14457	2 14488	2 14519	2 14550	2 14581	31
140	2 14767	2 14798	2 14829	2 14860	2 14891	30
141	2 15075	2 15106	2 15137	2 15167	2 15198	30
142	2 15381	2 15411	2 15442	2 15472	2 15503	30
143	2 15685	2 15715	2 15745	2 15775	2 15806	30
144	2 15986	2 16016	2 16046	2 16076	2 16106	30
145	2,16286	2,16316	2,16345	2,16375	2,16405	29

No.	0	1	2	3	4	Differ.
146	2.10433	2,10405	2,16494	2,16524	2,16554	29
147	2 16731	6761	6792	6820	6849	29
148	2 17026	7055	7084	7114	7143	29
149	2 17318	7347	7376	7406	7435	29
150	2 17609	7638	7667	7695	7724	28
151	2 17897	7926	7955	7983	8012	28
152	2 18184	8212	8241	8270	8298	28
153	2 18469	8 9	8525	8554	8582	28
154	2 18752	8780	8808	8836	8864	28
155	2 19033	9061	9089	9117	9145	27
156	2,19312	9340	9368	9 95	9421	27
157	2,19510	9617	9645	9672	9700	27
158	2,19865	2,19892	2,19920	2,199 8	2,19975	27
159	2 20139	2 20167	2,20191	2,20221	2,20448	27
160	2 20412	0439	0466	049	0520	27
161	2 20682	0709	0736	0763	07 0	26
162	2 20951	097	1005	1011	1058	26
163	2 21218	1245	1272	12 8	1325	26
164	2 21484	1510	1537	1563	1590	26
165	2 21748	1774	1801	1827	1853	26
166	2 22010	2037	206	2089	2115	25
167	2 22271	2297	2323	2349	2375	25
168	2,22530	2556	2582	2608	263	25
169	2,22788	2,22814	2,22840	2,2286	2,2 891	25
170	3044	3070	3096	3121	3147	25
171	3299	3325	3350	3375	3401	25
172	3552	3578	3603	3628	3653	24
173	3804	3829	3854	3879	3904	24
174	4054	4079	4104	4129	4154	24
175	4303	4328	4353	4378	4403	24
176	4551	4575	4600	4625	4649	24
177	4797	4821	4846	4870	4895	24
178	5042	5066	5090	5115	5039	24
179	5285	5309	5333	5358	5382	24
180	5527	5551	5575	5559	5624	2
181	2,25707	2,25791	2,25815	2,25839	2,25864	23
182	6007	6031	6054	6078	6102	23
183	6245	6268	6292	6316	6339	23
184	6481	6505	6529	6552	6576	23
185	6717	6740	6764	6787	6811	23
186	6951	6974	6998	7021	7044	23
187	7184	7207	7230	7253	727	
188	7415	7438	7462	74		23
189	7646	7669		7715	7738	22
190	7875	7898	7921	7943	7966	22
191	8103	8126	8148	8175	8194	2

No.	5	6	7	8	9	Differ.
146	2.16583	2,16613	2,16643	2,16672	2,16702	29
147	2 16879	6908	6938	6967	6996	29
148	2 17172	7201	7231	7260	7289	29
149	2 17464	7493	7522	7551	7580	29
150	2 17753	7782	7811	7840	7868	28
151	2 18041	8069	8098	8127	8155	28
152	2 18327	8355	8383	8412	8440	28
153	2 18610	8639	8667	8695	8723	28
154	2 18892	8920	8949	8977	9005	28
155	2 19173	9200	9228	9256	9284	27
156	2,19451	9479	9506	9534	9562	27
157	2,19728	9755	9783	9810	9838	27
158	2.20002	2.20030	2,20057	2,20085	2,20112	27
159	0276	0303	0330	0357	0384	27
160	0547	0574	0601	0628	0635	27
161	0813	0844	0873	0897	0924	26
162	1085	1112	1138	1165	1192	26
163	1351	1378	1404	1431	1457	26
164	1616	1643	1669	1695	1722	26
165	1879	1906	1932	1958	1984	26
166	2141	2167	2193	2219	2245	26
167	2401	2427	2453	2479	2505	25
168	2,22660	2,22685	2,22711	2,22737	2,22763	25
169	2,22917	2,22942	2,22968	2,22993	2,23029	25
170	3172	3197	3223	3248	3274	25
171	3426	3451	3477	3502	3527	25
172	3678	3704	3729	3754	3779	25
173	3929	3954	3980	4005	4029	25
174	4179	4204	4229	4254	4279	24
175	4437	4452	4477	4501	4526	24
176	4674	4699	4723	4748	4772	24
177	4919	4944	4968	4993	5017	24
178	5163	5188	5212	5236	5261	24
179	5406	5430	5454	5479	5503	24
180	5647	5671	5695	5719	5743	24
181	2,25887	2,25911	2,25935	2,25959	2,25983	23
182	6126	6150	6173	6197	6221	23
183	6363	6387	6411	6434	6458	23
184	6599	6623	6645	6670	6693	23
185	6834	6857	6881	6904	6927	23
186	7067	7091	7113	7137	7160	23
187	7300	7323	7346	7369	7392	23
188	7531	7554	7577	7600	7623	22
189	7760	7783	7806	7829	7852	22
190	7989	8012	8035	8057	8080	22
191	8216	8239	8262	8284	8307	22

No,	0	1	2	3	4	Differ,
192	2,28330	2,28352	2,28375	2,28397	2,28420	22
193	8555	8578	8600	8623	8645	22
194	8780	8802	8824	8847	8869	22
195	9003	9025	9048	9071	9092	22
196	9225	9247	9269	9292	9314	22
197	9446	9468	9490	9512	9534	22
198	9666	9688	9710	9732	9754	21
199	9885	9907	9928	9950	9972	21
200	2,30103	2,30124	2,30146	2,30168	2,30189	21
201	2,30319	2,30341	2,30362	2,30384	2,30405	21
202	2,30535	2,30556	2,30578	2,30599	2,30621	21
203	2,30749	2,30771	2,30792	2,30813	2,30835	21
204	2,30963	2,30984	2.31005	2,31026	2,31048	21
205	1175	1196	1217	1238	1260	21
206	1386	1487	1428	1449	1471	21
207	1597	1618	1639	1659	1680	20
208	1806	1827	1848	1868	1889	20
209	2014	2035	2056	2076	2097	20
210	2221	2242	2263	2283	2304	20
211	2428	2448	2469	2489	2510	20
212	2633	2654	2674	2695	2715	20
213	2838	2859	2878	2899	2919	20
214	3041	3061	3081	3102	3122	20
215	2,33243	2,33264	2,33284	2,33304	2,33324	20
216	3445	3465	3485	3505	3525	20
217	3646	3666	3686	3706	3726	20
218	3845	3865	3885	3905	3925	19
219	4044	4064	4084	4103	4123	19
220	4242	4262	4281	4301	4321	19
221	4439	4458	4478	4498	4517	19
222	4635	4654	4674	4693	4713	19
223	4830	4849	4869	4888	4908	19
224	5024	5044	5063	5082	5102	19
225	5218	5237	5256	5276	5295	19
226	5410	5430	5449	5468	5487	19
227	2,35602	2,35621	2,35640	2,35659	2,35679	19
228	5793	5812	5831	5850	5869	19
229	5983	6002	6021	6040	6059	19
230	6172	6191	6210	6229	6248	18
231	6361	6380	6398	6417	6436	18
232	6548	6567	6586	6604	6623	18
233	6735	6754	6772	6791	6810	18
234	6921	6940	6958	6977	6995	18
235	7106	7125	7143	7162	7180	18
236	7291	7309	7372	7346	7364	18
237	7474	7493	7511	7529	7548	18

No.	5	6	7	8	9	Differ.
192	2,28443	2,28465	2,28488	2,28510	2,28533	22
193	8668	8690	8713	8735	8757	22
194	8892	8914	8936	8958	8981	22
195	9114	9136	9159	9181	9203	22
196	9336	9358	9380	9402	9424	22
197	9556	9578	9600	9622	9644	22
198	9776	9757	9819	9841	9863	21
199	9994	0016	0037	2,30059	2,30081	21
200	2,30211	2,30231	2,30254	2,30276	2,30298	21
201	2,30427	2,30449	2,30470	2,30492	2,30513	21
202	2,30642	2,30663	2,30685	2,30706	2,30728	21
203	2,30856	2,30877	2,30899	2,30920	2,30941	21
204	2,31069	2,31090	2,31111	2,31133	2,31154	21
205	1281	1302	1323	1344	1365	21
206	1402	1513	1534	1555	1576	21
207	1701	1722	1743	1764	1784	20
208	1910	1931	1952	1973	1993	20
209	2118	2139	2159	2180	2201	20
210	2325	2345	2366	2387	2407	20
211	2531	2551	2572	2592	2613	20
212	2735	2756	2776	2797	2817	20
213	2939	2960	2980	3000	3021	20
214	3142	3162	3183	3203	3223	20
215	2,33344	2,33364	2,33385	2,33405	2,33425	20
216	3545	3565	3585	3605	3625	20
217	3748	3765	3785	3805	3825	20
218	3945	3965	3984	4004	4024	19
219	4142	4163	4183	4202	4222	19
220	4340	4360	4380	4399	4419	19
221	4537	4557	4576	4596	4615	19
222	4733	4752	4772	4791	4811	19
223	4927	4947	4966	4895	5005	19
224	5121	5150	5160	5179	5198	19
225	5314	5333	5353	5372	5391	19
226	5506	2,35526	2,35545	2,35564	2,35583	19
227	2,35698	5717	5736	5755	5774	19
228	5888	5907	5926	5945	5964	19
229	6078	6067	6116	6135	6153	18
230	6267	6285	6304	6323	6342	18
231	6455	6473	6492	6511	6530	18
232	6642	6661	6679	6698	6716	18
233	6828	6847	6865	6884	6903	18
234	7014	7032	7051	7069	7088	18
235	7109	7217	7236	7254	7272	18
236	7383	7401	7419	7438	7456	18
237	7566	7584	7602	7621	7639	18

No.	0	1	2	3	4	Differ.
238	2,37657	2,37675	2,37694	2,37712	2,37730	18
239	7839	7858	7876	7894	7912	18
240	8021	8039	8057	8075	8093	18
241	8201	8219	8237	8255	8273	18
242	8381	8399	8417	8435	8453	17
243	8560	8578	8596	8614	8632	17
244	8739	8756	8774	8792	8816	17
245	8916	8934	8952	8969	8987	17
246	9093	9111	9128	9146	9164	17
247	9269	9287	9304	9322	9340	17
248	9445	9462	9480	9497	9512	17
249	9619	9637	9654	9672	9689	17
250	2,39794	2,39811	2,39828	2,39846	2,39863	17
251	9967	9984	2,40002	2,40019	2,40063	17
252	2,40140	2,40157	0174	0191	0208	17
253	0312	0329	0346	0363	0380	17
254	0483	0500	0517	0534	0551	17
255	0654	0671	0688	0705	0722	17
256	0824	0840	0857	0874	0891	16
257	0993	1010	1027	1044	1060	16
258	1162	1178	1195	1212	1229	16
259	1330	1346	1363	1380	1397	16
260	1497	1514	1530	1547	1564	16
261	2,41664	2,41680	2,41697	2,41713	2,41730	16
262	1830	1846	1863	1879	1896	16
263	1995	2012	2028	2045	2061	16
264	2160	2176	2193	2209	2226	16
265	2324	2341	2357	2373	2390	16
266	2488	2504	2520	2537	2553	16
267	2651	2667	2683	2699	2716	16
268	2813	2829	2845	2862	2878	16
269	2975	2991	3007	3023	3039	16
270	3136	3152	3168	3184	3200	16
271	3296	3312	3329	3345	3361	16
272	2,43466	2,43472	2,43488	2,43504	2,43530	15
273	3616	3632	3648	3664	3679	15
274	3775	3790	3806	3722	3838	15
275	3933	3949	3964	3980	3996	15
276	4090	4106	4122	4138	4153	15
277	4248	4263	4279	4295	4310	15
278	4404	4420	4435	4451	4466	15
279	4560	4576	4591	4607	4622	15
280	4715	4731	4746	4672	4777	15
281	4870	4886	4901	4917	4932	15
282	5024	5040	5055	5071	5086	15

No.	5	6	7	8	9	Differ.
238	2,37748	2,37767	2,37785	2,37803	2,37821	18
239	7930	7948	7966	7984	8003	18
240	8111	8129	8147	8165	8183	18
241	8291	8309	8327	8345	8363	18
242	8471	8489	8507	8524	8542	17
243	8649	8667	8685	8703	8721	17
244	8827	8845	8863	8881	8896	17
245	9005	9022	9040	9058	9075	17
246	9181	9199	9216	9234	9252	17
247	9357	9375	9392	9410	9427	17
248	9532	9550	9567	9585	9602	17
249	9707	9724	9741	9759	9776	17
250	2,39880	2,39898	2,39915	2,39932	2,39950	17
251	2,40053	2,40071	2,40088	2,40105	2,40122	17
252	0326	0243	0260	0277	0294	17
253	0497	0404	0432	0449	0466	17
254	0568	0585	0612	0619	0637	17
255	0739	0756	0773	0790	0807	17
256	0908	0925	0942	0959	0976	16
257	1077	1094	1111	1128	1145	16
258	1245	1262	1279	1296	1313	16
259	1413	1430	1447	1463	1480	16
260	1580	1597	1614	1630	1647	16
261	2,41747	2,41763	2,41780	2,41797	2,41813	16
262	1912	1929	1946	1962	1979	16
263	2078	2094	2111	2127	2143	16
264	2242	2259	2275	2291	2308	16
265	2406	2422	2439	2455	2471	16
266	2569	2586	2602	2618	2634	16
267	2732	2748	2764	2781	2797	16
268	2894	2910	2926	2942	2959	16
269	3055	3072	3088	3104	3120	16
270	3216	3232	3248	3264	3280	16
271	3377	3393	3409	3424	3440	16
272	2,43536	2,43552	2,43868	2,43584	2,43600	15
273	3695	3711	3727	3743	3759	15
274	3854	3870	3885	3901	3917	15
275	4012	4027	4043	4059	4075	15
276	4169	4185	4200	4216	4232	15
277	4326	4341	4357	4373	4388	15
278	4482	4498	4513	4529	4544	15
279	4638	4653	4669	4684	4700	15
280	4793	4808	4824	4839	4855	15
281	4947	4963	4978	4994	5009	15
282	5101	5117	5132	5147	5163	15

No.	0	1	2	3	4	Differ.
283	2,45178	2,45194	2,45209	2,45224	2,45240	15
284	5331	5347	5362	5377	5393	15
285	5484	5499	5514	5530	5545	15
286	5686	5651	5667	5682	5697	15
287	5788	5800	5818	5833	5848	15
288	5939	5954	5969	5984	5999	15
289	6089	6104	6119	6134	6149	15
290	6239	6254	6269	6284	6299	15
291	6389	6404	6419	6434	6448	15
292	6538	6553	6568	6582	6597	14
293	6686	6701	6716	6731	6746	14
294	6834	6842	6864	6879	689.	14
295	2,46982	2,46911	2,46911	2,47026	2,47041	14
296	7129	7143	7158	7173	7187	14
297	7275	7290	7304	7319	7334	14
298	7421	7436	7450	7465	7479	14
299	7567	7581	7596	7610	7625	14
300	7712	7726	7741	7755	7770	14
301	7856	7871	7885	7899	7914	14
302	8000	8015	8029	8042	8058	14
303	8144	8158	8172	8187	8201	14
304	8287	8301	8315	8330	8344	14
305	2,48430	2,48444	2,48458	2,48472	2,48486	14
306	2,48572	2,48586	2,48600	2,48614	8628	14
307	8713	8728	8742	8756	8770	14
308	8855	8869	8883	8897	8911	14
309	8995	9009	9023	9038	9052	14
310	9136	9150	9164	9138	9192	13
311	9276	9290	9304	9317	9331	13
312	9415	9429	9443	9457	9471	13
313	9454	9568	9582	9596	9608	13
314	9663	9796	9723	9734	9648	13
315	9831	9844	9858	9872	9886	13
316	9968	9982	9996	2,50010	2,50023	13
317	2,50105	2,50119	2,50133	2,50147	2,50160	13
318	2,50242	2,50256	2,50270	2,50283	2,50297	13
319	0379	0392	0406	0419	0433	13
320	0515	0528	0542	0555	0569	13
321	0650	0664	0677	0691	0704	13
322	0785	0799	0812	0826	0839	13
323	0920	0933	0947	0960	0974	13
324	1054	1067	1081	1094	1108	13
325	1188	1201	1215	1228	1241	13
326	1321	1335	1348	1361	1375	13
327	1454	1468	1481	1494	1507	13
328	1587	1600	1613	1627	1640	13

No.	5	6	7	8	9	Diffr.
283	2,45255	2,45270	2,45285	2,45301	2,45316	15
284	5408	5342	5438	5454	5469	15
285	5560	5575	5591	5606	5621	15
286	5712	5727	5742	5757	5773	15
287	5863	5878	5894	5909	5924	15
288	6014	6029	6044	6036	6074	15
289	6164	6179	6194	6209	6224	15
290	6314	6329	6344	6359	6374	15
291	6463	6478	6493	6508	6523	14
292	6612	6627	6642	6657	6671	14
293	6760	6775	6790	6805	682	14
294	6908	6923	6938	6952	2,46967	14
295	2,47055	2,47070	2.47085	2,47099	2,47114	14
296	7202	7217	7231	7246	7261	14
297	7348	7363	7377	7392	7407	14
298	7494	7509	7523	7538	7552	14
299	7639	7654	7668	7683	7697	14
300	7784	7798	7813	7827	7842	14
301	7928	7943	7917	7971	7986	14
302	8072	8086	8101	8115	8129	14
303	8215	8230	8242	8258	8273	14
304	8358	8373	8387	8401	8415	14
305	8501	8515	8529	8513	8557	14
306	2,48643	2,48657	8671	2,48605	2,48699	14
307	8784	8796	8812	8826	8841	14
308	8925	8939	8953	8967	8981	14
309	9066	9080	9094	9108	9122	14
310	9206	9200	9234	9248	9262	14
311	9345	9359	9373	9387	9401	13
312	9485	9498	9512	9526	9540	13
313	9623	9637	9651	9665	9679	13
314	9784	9775	9789	9803	2,49817	13
315	9899	9844	9927	9941	2,49955	13
316	2,50037	2,50051	2,50094	2,50078	2,50092	13
317	2,50174	2,50188	2,50201	2,50215	2,50229	13
318	2,50310	2,50324	2,50338	2,50351	0365	13
319	0447	0460	0474	0487	0501	13
320	0582	0596	0609	0623	0637	13
321	0718	0731	0745	0750	0772	13
322	0853	0866	0879	0893	0906	13
323	0997	1000	1014	1027	1041	13
324	1121	1134	1148	1161	1175	13
325	1255	1268	1281	1295	1308	13
326	1388	1401	1414	1428	1441	13
327	1521	1534	1547	1560	1574	13
328	1653	1666	1580	1693	1760	13

No.	0	1	2	3	4	Differ.
329	2,51719	2,51732	2,51746	2,51759	2,51772	13
330	1851	1864	1877	1890	1904	13
331	1982	1995	2009	2022	2035	13
332	2113	2126	2140	2153	2166	13
333	2244	2257	2270	2283	2296	13
334	2374	2387	2400	2413	2426	12
335	2504	2517	2530	2543	2556	12
336	2633	2646	2659	2672	2685	12
337	2763	2775	2778	2801	2814	12
338	2891	2904	2917	2930	2943	12
339	3020	3032	3045	3058	3071	12
340	3147	3160	3173	3186	3198	12
341	2,53275	2,53288	2,53300	2,53313	2,53326	12
342	3402	3415	3428	3440	3453	12
343	3529	3542	3554	3567	3580	12
344	3655	3668	3681	3693	3706	12
345	3781	3794	3807	3819	3832	12
346	3907	3920	3932	3945	3957	12
347	4032	4046	4058	4070	4083	12
348	4157	4170	4182	4195	4207	12
349	4282	4295	4307	4319	4332	12
350	4406	4419	4431	4444	4456	12
351	4530	4543	4555	4567	4580	12
352	2,54654	2,54666	2,54678	2,54691	2,54703	12
353	4777	4789	4802	4814	4826	12
354	4900	4912	4924	4937	4949	12
355	5022	5035	5047	5059	5071	12
356	5145	5157	5169	5181	5193	12
357	5266	5278	5291	5303	5315	12
358	5388	5400	5412	5424	5432	12
359	5509	5521	5533	5545	5557	12
360	5630	5642	5654	5666	5678	12
361	5750	5762	5774	5786	5798	11
362	5870	5882	5894	5906	5918	11
363	2,55990	2,56002	2,56014	2,56026	2,56038	11
364	6110	6122	6134	6145	6157	11
365	6229	6241	6253	6265	6276	11
366	6348	6360	6371	6383	6395	11
367	6466	6478	6490	6502	6513	11
368	6584	6596	6608	6620	6632	11
369	6702	6714	6726	6737	6749	11
370	6820	6831	6843	6855	6867	11
371	6937	6949	6960	6972	6984	11
372	7054	7066	7077	7089	7101	11
373	7170	7182	7194	7205	7217	11
374	7287	7298	7310	7322	7333	11

No.	5	6	7	8	9	Diff.
329	2,51785	2,51798	2,51811	2,51825	2,51838	13
330	1917	1930	1943	1956	1969	13
331	2048	2061	2074	2087	2100	13
332	2179	2192	2205	2218	2231	13
333	2309	2322	2335	2348	2361	13
334	2439	2452	2465	2478	2491	12
335	2569	2582	2595	2608	2621	12
336	2698	2711	2724	2737	2750	12
337	2827	2840	2853	2866	2878	12
338	2955	2968	2981	2991	3007	12
339	3084	3096	3109	3122	3135	12
340	3211	3224	3237	3250	3262	12
341	2,53339	2,53351	2,53364	2,53377	2,53389	12
342	3466	3478	3491	3504	3516	12
343	3512	3602	3617	3630	3642	12
344	3718	3731	3744	3756	3769	12
345	3844	3854	3869	3882	3895	12
346	3970	3982	3995	4007	4020	12
347	4095	4108	4120	4133	4145	12
348	4220	4232	4245	4255	4270	12
349	4344	4357	4369	4382	4394	12
350	4468	4481	4493	4506	4518	12
351	4592	4605	4617	4629	4641	12
352	2,54715	2,54728	2,54740	2,54752	2,54765	12
353	4838	4851	4863	4875	4888	12
354	4961	4973	4986	4998	5010	12
355	5084	5096	5108	5120	5132	12
356	5205	5218	5230	5242	5254	12
357	5227	5339	5351	5364	5376	12
358	5448	5461	5473	5485	5497	12
359	5569	5582	5594	5606	5618	12
360	5690	5702	5714	5726	5738	12
361	5820	5822	5834	5846	5858	11
362	5930	5942	5954	5966	5978	11
363	2,56050	2,56062	2,56074	2,56086	2,56098	11
364	6169	6181	6193	6205	6217	11
365	6288	6300	6312	6324	6336	11
366	6407	6429	6431	6442	6454	11
367	6525	6537	6549	6561	6572	11
368	6643	6655	6667	6679	6690	11
369	6761	6773	6784	6796	6808	11
370	6878	6890	6902	6914	6925	11
371	6995	7007	7019	7030	7042	11
372	7112	7124	7135	7147	7159	11
373	7229	7240	7252	7263	7275	11
374	7345	7356	7368	7380	7391	11

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No.	0	1	2	3	4	Diffr.
375	2,57403	2,57414	2,57425	2,57437	2,57449	11
376	7518	7530	7541	7553	7565	11
377	7634	7645	7657	7668	7680	11
378	7749	7760	7772	7783	7795	11
379	7863	7875	7888	7898	7909	11
380	7978	7989	8001	8013	8024	11
381	8002	8103	8115	8126	8138	11
382	8206	8217	8229	8240	8251	11
383	8319	8331	8345	8353	8365	11
384	2,58433	2,58444	2,58455	2,58467	2,58478	11
385	8546	8557	8568	8579	8591	11
386	8658	8670	8681	8692	8703	11
387	8771	878	8793	8804	8816	11
388	8883	8894	8905	8916	8927	11
389	8995	8906	9017	9028	9039	11
390	9106	9017	9128	9139	9151	11
391	9217	9228	9239	9257	9262	11
392	9328	9339	9350	9361	9372	11
393	2,59439	2,59450	2,59461	2,59472	2,59433	11
394	9549	9560	9571	9532	9593	11
395	9659	9670	9681	9692	9703	11
396	9769	9780	9791	9802	9813	11
397	9879	9890	9900	9991	9922	10
398	9988	9999	2,60010	2,60021	2,60031	10
399	2,60097	2,60108	0119	0129	0140	10
400	0206	0216	0227	0238	0249	10
401	0314	0325	0336	0346	0357	10
402	2,60422	2,60433	2,60444	2,60455	2,60465	10
403	0530	0541	0552	0562	0573	10
404	0638	0648	0659	0670	0681	10
405	0745	0756	0766	0777	0788	10
406	0852	0863	0874	0884	0895	10
407	0949	0970	0980	0991	1002	10
408	1066	1076	1087	1097	1108	10
409	1172	1182	1193	1204	1214	10
410	1278	1289	1299	1310	1320	10

No.	5	6	7	8	9	Diff.
375	2,57461	2,57472	2,57484	2,57495	2,57507	11
376	7576	7588	7599	7611	7622	11
377	7691	7703	7714	7726	7737	11
378	7806	7818	7829	7841	7852	11
379	7921	7932	7944	7955	7966	11
380	8035	8046	8085	8069	8081	11
381	8149	8160	8172	8183	8195	11
382	8263	8274	8285	8267	830	11
383	8376	8387	8399	8410	2,5845	11
384	2,58489	2,58500	2,58512	2,58523	2,58534	11
385	8602	8613	8625	8636	8647	11
386	8714	8726	8737	8748	8759	11
387	8827	8838	8849	8860	8872	11
388	8939	8950	8961	8972	8983	11
389	9050	9061	9073	908	9095	11
390	9162	9173	9184	9195	9206	11
391	9273	9284	9295	9306	9317	11
392	9384	9395	9406	9417	9428	11
393	2,59494	2,59505	2,59516	2,59527	2,59538	11
394	2,59604	9615	9626	9637	9648	11
395	2,59814	9725	9736	9747	9758	11
396	2,59824	9835	9846	9857	9868	11
397	2,59933	9944	9955	9966	9977	10
398	2,60042	2,60053	2,60064	2,60075	2,60086	10
399	0151	0162	0173	0184	0195	10
400	0260	0271	0281	0292	0303	10
401	0368	0379	0390	0401	0411	10
402	2.60476	2,60487	2.60498	2,60508	2,60519	10
403	0584	0595	0605	0616	0627	10
404	0691	0702	0713	0724	0734	10
405	0799	0809	0820	0831	0841	10
406	0906	0916	0927	0938	0948	10
407	1012	1023	1034	1044	1055	10
408	1119	1129	1140	1151	1161	10
409	1225	1236	1246	1257	1267	10
410	1331	1341	1352	1363	1373	10

The Use of the Table of Logarithms of Numbers, from 1 *to* 4000.

1ſt. THE Logarithm of any number under 10, is found in the firſt column in the firſt page, the index or characteriſtic thereof, is 0, as per Table.

2d, The Logarithm of any number under 100, is found in the ſecond column of firſt four pages, &c. under 0, at top as per Table.

Example 1ſt. Required the Logarithm of 84?

Under 0, at the top, and againſt it the firſt column of the left hand ſide, find 84, againſt which is 1,9242, the Logorithm required.

To find the Log. of numbers above 100 in the foregoing pages.

Rule. Find the two firſt figures in the firſt column on the left hand ſide of ſome of the four firſt pages in the table, and the figure in the unite place againſt which in the ſecond column is the Logarithm required.

Example. Let it be required to find the Logarithm of 397.
Find 39 in the firſt column in the left hand ſide and 7 at the top, then againſt 39, and under 7 you have 2,59379 the Logarithm required.

Example 3d. Let be required to find the Logarithm of 1795.

Look for 179 in the 1ſt. column, on ſome of the pages from the fifth to the end of the Table, and on the left hand ſide, and 5 the unite figure at the top, then againſt 179 and under 5, you will have 3,25400 the Logarithm required.

Example 4th. Let it be required to find the Logarithm of 3919.

Look for 391 in the firſt column in the left hand ſide, and under 9 at the top, then againſt 391 and under 9, you will have 3,59317 the Logarithm required.

A

TABLE,

OF

NATURAL and ARTIFICIAL Sines and Tangents;

The Radius 1, in Natural Sines and Tangents, and 10,00000 in Artificial, &c. to every Degree and Two Minutes of the Quadrant.

0 Degrees.

M	N, fi.		N.T.		Log. S.		Log. T,		
1	0003	1,000	0003	343,74	6,46372	9,99999	6,46372	13.53627	59
3	0009	9999	0008	114,59	6,94084	9,99999	6,94084	13,05915	57
5	0014	9999	0014	68,754	7,16269	9,99999	7,16269	12,83730	55
7	0020	9999	0020	49,110	7,30882	9,99999	7,30882	2,69117	53
9	0026	9999	0026	38,197	7,41796	9,99999	7,41797	12,58203	51
11	0032	9999	0032	31,252	7,50511	9,99999	7,50512	2.49488	49
13	0038	9999	0037	26,444	7.57766	9.99999	7,57767	12,42233	47
15	0047	9999	0043	22,918	7,63981	9 99999	7,63982	12,36018	45
17	0049	9999	0046	20,222	7,69417	9,99999	7.69417	12,30582	43
19	0055	9999	0051	18,093	7,74247	9.99999	7.74248	12,25751	41
21	0061	9999	0061	16,370	7,78594	9,99999	7,78595	12.21405	39
23	0067	9999	0067	14,946	7,82545	9,99999	7,82546	12.17454	37
25	0072	9999	0072	13,751	7,86166	9,99999	7,86167	12.13832	35
27	0078	9999	0078	12,732	7,89503	9,99999	7,89510	12.10490	33
29	0084	9999	0084	11,854	7,92612	9,99999	7,92613	12.07386	31
31	0090	9999	0090	11,089	7,95508	9.99998	7,95510	12.04490	29
33	0096	9999	0096	10,417	7,98223	9,99998	7,98225	12,01774	27
35	0102	9999	0102	09,821	8,00778	9,99997	8,00781	11.99219	25
37	0107	9999	0108	09,290	8,03191	9.99997	8,03194	11,96805	23
39	0113	9999	0113	08,814	8,05478	9.99997	8,05480	11,94519	21
41	0119	9998	0119	08,384	8,07649	9,99996	8,07653	11.92347	19
43	0125	9998	0125	07,994	8,09718	9.99996	8,09721	11.90278	17
45	0131	9998	0131	07,639	8,11692	9.99996	8,11696	11,88303	15
47	0137	9998	0136	07,313	8,13581	9.99996	8,13585	11,86415	13
49	0142	9998	0142	07,015	8,15390	9,99995	8,15395	11.84604	11
51	0148	9998	0148	06,740	8,17128	9,99995	8,17132	11,82867	9
53	0154	9998	0154	06,485	8,18798	9,99995	8,18803	11,81196	7
55	0160	9998	0160	06,249	8,20407	9,99994	8,20412	11,79587	5
57	0166	9998	0166	06,030	8,21958	9,99993	8,21964	11.78035	3
59	0171	9998	0172	05,826	8,23455	9,99993	8,23462	11,76537	1
	C, S,	N.S.	C.T.	N. T.	co.fine	Log. *S.*	co. tan.	Log.tang.	M

89 Degrees.

1 Degrees,

M	N.si.		N,T,		Log. si.		Log,T.		
1	0177	9998	0177	5,635	8.24903	9,99993	8,24910	11,75808	59
3	0183	9998	0183	5,456	8,26304	9,99992	8,26311	11,73688	57
5	0189	9998	0189	5,288	8,27661	9,99992	8,27669	11.72330	55
7	0194	9998	0194	5,130	8,28977	9,99991	8,28985	11,71014	53
9	0200	9998	0200	4.981	8,30254	9,99991	8,30262	11,69786	51
11	0206	9997	0206	4,841	8,31495	9,99991	8,31504	11,68495	49
13	0212	9997	0212	4,708	8,32701	9,99991	8,32711	11,67288	47
15	0218	9997	0218	4,582	8,33875	9,99990	8,33805	11,66114	45
17	0223	9997	0224	4,463	8,35018	9,99990	8,35028	11,64971	43
19	0229	9996	0229	4,350	8,36131	9,99988	8,36142	11.63857	41
21	0235	9996	0235	4,243	8,37217	9,99987	8,37229	11,62770	39
23	0241	9996	0241	4,141	8,38276	9,99986	8,38288	11.61711	37
25	0247	9996	0247	4.043	8,39310	9,99988	8.39323	11,60676	35
27	0253	9996	0253	3,951	8,40320	9,99988	8,40333	11.59666	33
29	0258	9996	0258	3,863	8,41306	9,99985	8.41321	11,58678	31
31	0264	9996	0264	3,778	8,42271	9,99984	8,42286	11.57713	29
33	0270	9996	0270	3,696	8,43215	9,99985	8.43231	11.56768	27
35	0276	9996	0276	3,619	8,44139	9.99983	8.44155	11.55860	25
37	0282	9996	0282	3,544	8.45044	9.99981	8,45061	11.54955	23
39	0287	9995	0288	3.473	8,45930	9,99981	8.45948	11.54051	21
41	0293	9995	0293	3,404	8,46798	9,99981	8,46817	11,53181	19
43	0299	9995	0299	3,338	8,47649	9,99980	8,47669	11.52330	17
45	0308	9995	0305	3,274	8,48484	9.99979	8.48505	11.51454	15
47	0311	9994	0311	3,213	8,49303	9,99978	8,49325	11,50675	13
49	0317	9994	0317	3,154	8,50108	9,99978	8,50129	11.49870	11
51	0322	9994	0322	3,097	8,50897	9.99977	8,50920	11,49080	9
53	0328	9993	0328	3.041	8,51672	9,99976	8,51696	11,48304	7
55	0334	9993	0334	2.988	8,52434	9,99975	8,52458	11.47741	5
57	0340	9993	0340	2,937	8,53182	9,99974	8,53287	11,46792	3
59	0346	9993	0346	2,887	8,53918	9,99970	8,53914	11.46056	1
		N,si.		N,T		Log, si.		Log.tang,	M

88 Degrees

2 Degrees,

M	N, si,		N, T,		Log, S,		Log, T.		
1	0352	9993	0352	2,839	8,54642	9,99973	8,54669	11,45331	59
3	0357	9993	0358	2,796	8.55353	9,99972	8,55381	11.44618	57
5	0363	9993	0363	2,749	8,56054	9,99971	8,56082	11.43917	55
7	0369	9993	0369	2,705	8,56743	9,99970	8,56772	11.43227	53
9	0375	9993	0375	2,663	8,57421	9,99969	8,57452	11.42548	51
11	0386	9992	0381	2,622	8,57756	9,99968	8,58120	11,41879	49
13	0387	9992	0387	2.583	8,58747	9,99967	8,58779	11,41220	47
15	0392	9992	0393	2,545	8,59394	9,99966	8,59428	11,40571	45
17	0398	9992	0398	2,507	8,60033	9,99965	8,60067	11,39932	43
19	0404	9991	0404	2,472	8,60662	9,99964	8,60697	11.39302	41
21	0410	9991	0410	2,436	8,61282	9,99963	8,61318	11,38681	39
23	0415	9991	0416	2.402	8,61893	9,99962	8,61931	11,38068	37
25	0421	9991	0422	2,369	8,62496	9,99961	8,62535	11,37464	35
27	0427	9990	0427	2,337	8,63091	9,99960	8,63130	11,36869	33
29	0433	9990	0433	2,305	8,63677	9,99959	8,63718	11.36281	31
31	0439	9990	0439	2,275	8,64256	9,99958	8,64298	11,35701	29
33	0444	9990	0445	2.245	8,64827	9,99956	8,64870	11.35129	27
35	0450	9989	0451	2,216	8,65391	9,99955	8,65435	11,34564	25
37	0456	9989	0457	2,188	8,65947	9,99954	8,65992	11.34007	23
39	0462	9989	0462	2,160	8,66496	9,99953	8.66543	11,33456	21
41	0468	9989	0468	2,133	8,67039	9,99952	8,67086	11,32913	19
43	0473	9988	0474	2,107	8,67575	9,99951	8,67624	11,32376	17
45	0479	9988	0480	2,081	8,68104	9,99949	8,68154	11.31445	15
47	0455	9988	0486	2,056	8,68627	9,99948	8.68678	11,31321	13
49	0491	9988	0491	2,032	8,69143	9,99947	8,69196	11,30803	11
51	0497	9987	0497	2,008	8,69654	9,99946	8.69708	11,30291	9
53	0503	9987	0503	1,997	8,70158	9,99944	8.70218	11,29786	7
55	0508	9987	0509	1,962	8,70657	9,99943	8,70713	11,29286	5
57	0514	9986	0515	1,940	8,71150	9,99942	8.71208	11,28791	3
59	0520	9986	0521	1,918	8,71638	9,99941	8.71697	11,28302	1
		N, si.		N, T,		Log, S,		Log, tang,	M

87 Degrees,

3 Degrees,

M	N.fi.		N,T,		Log. fi.		Log.T.		
1	0526	9986	0526	18,97	8.72120	9,99940	8,72180	11,27820	59
3	0532	9985	0532	18,76	8,72597	9,99939	8,72658	11,27341	57
5	0537	9985	0538	18,56	8,73068	9,99937	8,73131	11.26868	55
7	0543	9985	0544	18,36	8,73535	9,99935	8,73599	11,26400	53
9	0549	9984	0550	18.17	8,73996	9,99934	8,74062	11,25937	51
11	0555	9984	0556	17,98	8,74454	9,99933	8,74521	11,25479	49
13	0561	9984	0562	17,79	8,74905	9,99931	8,74974	11,25026	47
15	0566	9983	0567	17,61	8,75353	9,99930	8,75422	11,24577	45
17	0572	9983	0573	17,43	8,75795	9,99928	8,75866	11,24133	43
19	0578	9983	0579	17,26	8,76233	9,99927	8,76306	11.23693	41
21	0584	9982	0585	17,08	8,76667	9,99925	8,76742	11,23258	39
23	0590	9982	0591	16,91	8,77097	9,99924	8,77173	11.22847	37
25	0595	9982	0597	16.74	8,77522	9,99922	8.77599	11,22400	35
27	0601	9981	0602	16,58	8,77943	9,99921	8,78022	11.21977	33
29	0607	9981	0608	16,42	8,78360	9,99919	8.78441	11,21559	31
31	0613	9981	0614	16,27	8,78773	9,99918	8,78855	11.21144	29
33	0619	9980	0620	16,11	8,79182	9,99916	8.79266	11.20734	27
35	0625	9980	0626	15,96	8,79588	9.99915	8,79673	11.20326	25
37	0630	9980	0632	15,82	8.79989	9.99913	8,80076	11.19923	23
39	0636	9979	0637	15.67	8,80387	9,99911	8.80475	11.19524	21
41	0642	9979	0643	15,53	8,80782	9,99910	8,80871	11,19128	19
43	0648	9978	0649	15,39	8,81172	9,99908	8,81264	11.18736	17
45	0654	9978	0655	15,25	8,81559	9.99907	8.81652	11.18347	15
47	0659	9978	0661	15,12	8,81943	9,99905	8,82238	11,17961	13
49	0665	9977	0667	14,98	8,82324	9,99903	8,82320	11.17579	11
51	0671	9977	0672	14,85	8,82701	9,99902	8,82799	11,17200	9
53	0677	9977	0678	14.73	8,83075	9,99901	8,83174	11,16825	7
55	0683	9976	0684	14.60	8,83445	9,99898	8,83547	11.16453	5
57	0688	9976	0690	14,48	8,83813	9,99896	8,83916	11,16083	3
59	0694	9975	0696	14,36	8,84177	9,99895	8,84282	11.15717	1
		N,fi.		N,T		Log, fi.		Log.tang,	M,

88 Degrees

4 Degrees,

M	N, si,		N.T,		Log, S,		Log, T.		
1	0700	9975	0702	1,424	8,84538	9,99893	8,84645	11,15354	59
3	0706	9975	0708	1,412	8.84897	9,99891	8,85005	11.14994	57
5	0712	9974	0713	1,400	8,85252	9,99889	8,85362	11.14637	55
7	0717	9974	0719	1.389	8,85605	9,99887	8,85717	11.14282	53
9	0723	9973	0725	1,378	8,85954	9,99886	8,86068	11,13931	51
11	0729	9973	0731	1,367	8,86128	9,99884	8,86417	11,13582	49
13	0735	9973	0737	1,356	8,86645	9,99882	8,86763	11,13236	47
15	0741	9972	0743	1,345	8,86986	9,99880	8,87106	11,12893	45
17	0746	9972	0748	1,335	8,87325	9,99878	8,87446	11,12553	43
19	0753	9971	0754	1,324	8,87661	9,99876	8,87785	11.12215	41
21	0758	9971	0760	1,314	8,87995	9,99874	8,88120	11,11879	39
23	0764	9971	0706	1,304	8,88326	9,99873	8,88453	11,11547	37
25	0770	9970	0772	1,294	8,88654	9,99870	8,88783	11,11216	35
27	0775	9979	0778	1,284	8,88980	9,99868	8,89111	11,10888	33
29	0781	9969	0784	1,275	8,89360	9,99866	8,89436	11.10563	31
31	0787	9969	0789	1,266	8,89464	9,99864	8,89759	11,10240	29
33	0793	9968	0795	1,256	8,89943	9,99862	8,90080	11,09919	27
35	0799	9968	0801	1,247	8,90259	9,99860	8,90398	11.09601	25
37	0804	9967	0807	1,238	8,90573	9,99859	8,90711	11.09284	23
39	0810	9967	0813	1,229	8,90885	9,99856	8.91028	11,08971	21
41	0816	9966	0819	1,220	8,91195	9,99854	8,91340	11,08660	19
43	0822	9966	0825	1,212	8,91522	9,99852	8,91649	11,08350	17
45	0828	9965	0830	1,203	8,91807	9,99850	8,91956	11.08043	15
47	0833	9965	0836	1,195	8,92110	9,99848	8.92262	11,07738	13
49	0839	9964	0842	1,186	8,92411	9,99846	8,92565	11,07435	11
51	0845	9964	0848	1,178	8,92710	9,99844	8.92866	11,07134	9
53	0851	9963	0854	1,170	8,93006	9,99842	8.93164	11,06835	7
55	0857	9963	0860	1,162	8,93301	9.99840	8,93461	11,06538	5
57	0862	9962	0866	1,154	8,93594	9.99837	8.93756	11,06249	3
59	0868	9962	0871	1,146	8,93885	9,99834	8.94041	11,05950	1
		N, si.		N,T,		Log, S,		Log, tang,	M

85 Degrees,

5 Degrees.

M	N, si.		N.T.		Log. S.		Log. T,		
1	0874	9961	0877	11,391	8,94173	9,99833	8,94340	11.05659	59
3	0880	9961	0883	11,316	8,94460	9,99831	8,94629	11.05370	57
5	0886	9960	0889	11,241	8,94745	9,99828	8,94917	11,05083	55
7	0891	9960	0895	11,168	8,95023	9,99826	8,95202	11,04798	53
9	0897	9959	0901	11,095	8,95310	9,99824	8,95485	11.04514	51
11	0903	9959	0907	11,023	8,95589	9,99822	8,95767	11,04232	49
13	0909	9958	0913	10,952	8,95867	9.99819	8,96047	11,03952	47
15	0915	9957	0918	10,882	8,96143	9.99817	8,96325	11,03674	45
17	0920	9957	0924	10,813	8,96417	9,99815	8,96602	11.03398	43
19	0926	9956	0930	10,745	8,96689	9.99812	8,96876	11,03123	41
21	0932	9956	0936	10,678	8,96960	9,99810	8,97149	11.02850	39
23	0938	9955	0942	10,611	8,97229	9,99808	8,97421	11,02579	37
25	0943	9955	0948	10,546	8,97496	9,99805	8.97690	11,02309	35
27	0949	9954	0954	10,48.	8,97762	9,99803	8.97958	11.02041	33
29	0955	9954	0959	10,417	8,98026	9,99800	8,98225	11.01775	31
31	0961	9953	0965	10,353	8,98288	9.99798	8,98490	11.01510	29
33	0967	9953	0971	10,291	8,98549	9,99795	8,98753	11.01246	27
35	0972	9952	0977	10,229	8,98808	9,99793	8,99015	11.00985	25
37	0978	9951	0983	10,168	8,99066	9.99791	8,99275	11,00725	23
39	0984	9951	0989	10,108	8,99322	9.99788	8,99533	11.00466	21
41	0990	9950	0995	10,048	8,99576	9,99786	8,99790	11.00209	19
43	0996	9950	1001	9,989	8,99830	9.99783	9,00046	10,99953	17
45	1001	9949	1006	9,931	9,00081	9.99781	9,00300	10,99697	15
47	1007	9949	1012	9,973	9,00331	9.99778	9,00553	10,99446	13
49	1013	9948	1018	9,816	9,00580	9,99775	9,00804	10,99195	11
51	1019	9947	1024	9,760	9,00827	9,99773	9,01054	10.98945	9
53	1025	9947	1030	9,704	9,01073	9,99771	9,01303	10,98696	7
55	1030	9946	1036	9,701	9,01318	9,99768	9,01550	10,98449	5
57	1036	9946	1042	9,649	9,01561	9,99765	9,01796	0,98204	3
59	1042	9945	1048	9,594	9,01803	9,99762	9,02040	10,97959	1
M	C. S.	N.S.	C.T.	N. T.	co. fine	Log. S.	co. tan.	Log. tang.	M

84 Degrees.

6 Degrees

M	N,si,		N,T,		Log. si,		Log.T,		
1	1048	9945	1054	9,487	9,02043	9.99768	9.02283	10.97716	59
3	1054	9944	1059	9,435	9.02282	9.99757	9,02525	10,97475	57
5	1059	9943	1065	9,383	9,02520	9.99756	9,02765	10,97234	55
7	1065	9943	1071	9,331	9,02756	9,99752	9,03004	0.96995	53
9	1071	9942	1077	9,280	9,02992	9,99749	9,03242	10.96757	51
11	1077	9941	1083	9,230	9.03225	9,99746	9,03479	10,96521	49
13	1082	9940	1089	9.180	9,03458	9.99743	9.03714	0,96285	47
15	1088	9940	1095	9,130	9,03689	9,99741	9.03961	0,96051	45
17	1094	9939	1101	9,082	9.03919	9,99738	9,04181	10,95818	43
19	1100	9939	1106	9,033	9,04145	9,99735	9,04413	10,95587	41
21	1106	9938	1112	8,986	9,04376	9,99732	9,04643	10.95396	39
23	1111	9938	1118	8.938	9,04602	9,99730	9,04872	10.95127	37
25	1117	9937	1124	8,891	9,04828	9,99727	9,05100	10.94899	35
27	1023	9936	1130	8,845	9,05052	9,99724	9,05327	10,94672	33
29	1129	9936	1136	8.799	9,05274	9,99721	9,05553	10.94446	31
31	1134	9935	1142	8,754	9,05496	9,99718	9,05778	10,94222	29
33	1140	9934	1148	8.709	9.05717	9,99715	9.06001	10.93998	27
35	1146	9934	1154	8,664	9.05936	9,99712	9.06224	10,93776	25
37	1152	9933	1159	8,620	9.06155	9,99709	9,06445	10,93554	23
39	1158	9932	1165	8,577	9,06372	9,99706	9.06665	10,93334	21
41	1163	9932	1171	8,534	9,06588	9,99703	9,06884	10,93115	19
43	1169	9931	1177	8.491	9,06803	9.99701	9,07102	10.92897	17
45	1175	9930	1183	8.449	9.07017	9,99698	9,07319	10,92680	15
47	1181	9929	1189	8,407	9.07230	9.99694	9.07538	10.92464	13
49	1186	9929	1195	8,365	9.07442	9,99692	9,07750	10.92249	11
51	1192	9928	1101	8,324	9,07653	9,99689	9,07964	10,92035	9
53	1198	9927	1102	8,283	9,07863	9.99685	9,08177	10.91822	7
55	1204	9927	1113	8.243	9,08071	9,99683	9,08389	10,91611	5
57	1210	9926	1118	8,203	9,08279	9.99679	9,08600	10,91400	3
59	1215	9925	1124	8,164	9,08486	9,99676	9,08819	10,91190	1
		N.S.		N,T,		Log, si,		Log,tang.	M

83 Degrees

7 Degrees

M	N,si,		N,T,		Log. si,		Log. T,		
1	1221	9925	1230	8,124	9,08692	9.99673	9.08918	10.90981	59
3	1227	9924	1236	8.086	9.08891	9.99670	9,09226	10,90773	57
5	1233	9923	1242	8,047	9,09100	9,99667	9,09433	10,90566	55
7	1238	9923	1248	8,009	9,09303	9,99664	9,09639	10.90360	53
9	1244	9922	1254	7.991	9,09501	9,99661	9,09844	10.90155	51
11	1250	9921	1260	7,953	9.09706	9,99657	9,10048	10,89951	49
13	1256	9921	1266	7,897	9,09906	9,99654	9.10252	10,89748	47
15	1261	9920	1277	7.860	9,10105	9,99651	9.10454	10,89545	45
17	1267	9919	1278	7,824	9.10303	9,99648	9,10655	10,89344	43
19	1273	9918	1283	7,788	9,10501	9,99644	9,10856	10,89144	41
21	1279	9917	1289	7,752	9,10697	9,99641	9,11055	10.88944	39
23	1285	9917	1295	7,717	9,10892	9,99638	9,11254	10.88745	37
25	1290	9916	1301	7,682	9,11087	9,99635	9,11452	10.88547	35
27	1296	9915	1307	7,647	9,11283	9,99631	9,11649	10,88351	33
29	1302	9914	1313	7,613	9,11473	9,99628	9,11845	10.88154	31
31	1308	9914	1319	7,578	9,11665	9,99625	9,12040	10,87959	29
33	1314	9913	1325	7°544	9.11856	9,99622	9.12234	10.87765	27
35	1319	9912	1331	7°511	9.12046	9,99618	9.12428	10,87571	25
37	1325	9911	1337	7,478	9.12236	9,99615	9,12621	10,87379	23
39	1330	9910	1343	7,445	9,12424	9,99611	9.12813	10,87187	21
41	1337	9910	1349	7,412	9,12614	9,99608	9,13004	10,86996	19
43	1342	9909	1355	7.350	9,12799	9.99604	9,13194	10.86805	17
45	1348	9908	1360	7.347	9.12985	9,99601	9,13383	10,86616	15
47	1354	9907	1366	7.316	9.13170	9.99599	9.13572	10.86427	13
49	1360	9907	1372	7,284	9.13355	9,99596	9,13760	10.86239	11
51	1365	9906	1378	7,253	9.13538	9,99591	9,13947	10,86052	9
53	1371	9905	1384	7,222	9,13721	9.99587	9,14134	10.85866	7
55	1377	9904	1390	7.191	9,13903	9,99584	9,14319	10,85680	5
57	1383	9903	1396	7,160	9,14085	9.99580	9,14504	10,85495	3
59	1388	9903	1402	7.130	9,14265	9,99577	9,14688	10,85311	1
		N.S.		N,T,		Log, si,		Log, tang.	M

82 Degrees

8 Degrees.

M	N.si.		N,T,		Log. si.		Log,T.		
1	1394	9902	1408	7,100	9,14445	9,99573	9,14871	10,85128	59
3	1400	9901	1414	7,070	9,14624	9,99569	9,15054	10,84945	57
5	1406	9900	1420	7,041	9,14802	9,99566	9,15236	10.84763	55
7	1411	9899	1426	7,011	9,14980	9,99562	9,15417	10,84582	53
9	1417	9899	1432	6,982	9,15155	9,99559	9,15597	10,84402	51
11	1423	9898	1438	6,953	9,15333	9,99555	9,15777	10,84222	49
13	1429	9897	1443	6,925	9.15508	9,99551	9,15956	10,84043	47
15	1434	9896	1449	6,896	9,15683	9,99548	9,16134	10,83865	45
17	1440	9895	1455	6,868	9,15856	9,99544	9,16312	10,83687	43
19	1446	9894	1461	6,840	9,16030	9,99540	9,16489	10.83511	41
21	1452	989	1467	6,813	9,16202	9,99537	9,16665	10,83334	39
23	1457	9893	1473	6,785	9,16374	9,99533	9,16841	10.83159	37
25	1463	9892	1479	6.758	9,16545	9,99529	9.17015	10,82984	35
27	1469	9891	1485	6,731	9,16716	9,99526	9,17189	10.82810	33
29	1475	9890	1491	6,704	9,16888	9,99522	9.17363	10,82636	31
31	1480	9889	1497	6,677	6,17054	9,99518	9,17536	10.82463	29
33	1486	9888	1503	6,651	9,17223	9,99514	9.17708	10.82291	27
35	1492	9887	1509	6,625	9,17390	9.99510	9.17879	10.82120	25
37	1498	9887	1515	6,599	9.17557	9.99507	9,18050	10.81949	23
39	1503	9886	1521	6.573	9,17724	9,99503	9.18221	10.81778	21
41	1509	9886	1527	6,547	9,17890	9,99499	9,18390	10,81609	19
43	1515	9884	1533	6,522	9,18055	9,99495	9,18559	10.81440	17
45	1521	9883	1539	6,497	9,18219	9.99491	9.18728	10.81272	15
47	1526	9882	1545	6,472	9,18383	9,99487	9,18893	10,81104	13
49	1532	9881	1551	6,447	9,18546	9,99483	9,19062	10,80937	11
51	1538	9880	1557	6,422	9,18709	9,99479	9,19229	10,80770	9
53	1544	9880	1563	6.398	9,18871	9,99475	9,19395	10,80604	7
55	1549	9879	1568	6.373	9,19032	9,99472	9,19560	10,80439	5
57	1555	9878	1574	6,349	9,19193	9,99468	9,19725	10,80274	3
59	1561	9877	1580	6,325	9,19353	9,99464	6,19889	10.80110	1
		N,si.		N,T		Log, si.		Log.tang,	M

81 Degrees

9 Degrees.

M	N, si.		N.T,		Log. S.		Log. T,		
1	1567	9876	1586	6,301	9,19512	9,99460	9,20053	10,79947	59
3	1572	9875	1592	6,278	9,19672	9,99496	9,20216	10,79784	57
5	1578	9874	1598	6,254	9,19830	9,99452	9,20378	10.79621	55
7	1584	9873	1604	6,231	9,19957	9,99447	9,20540	10,79460	53
9	1590	9872	1610	6,208	9,20145	9,99443	9,2070	10,79298	51
11	1595	9871	1616	6,185	9,20301	9,99439	9,20862	10,79138	49
13	1601	9870	1622	6,162	9,20457	9,99435	9,21022	10.78978	47
15	1607	9869	1628	6,140	9,20613	9,99431	9,21181	10.78818	45
17	1613	9869	1634	6,117	9,20767	9,99427	9,21340	10.78659	43
19	1618	9868	1640	6,095	9,20922	9,99423	9,21499	10.78501	41
21	1624	9867	1646	6,073	9,21076	9,99419	9,21657	10.78343	39
23	1630	9866	1652	6,051	9,21229	9,99415	9,21814	10.78185	37
25	1636	9865	1658	6,029	9,21381	9,99410	9,21971	10,78029	35
27	1641	9864	1664	6,007	9,21533	9,99406	9,22127	10.77873	33
29	1647	9863	1670	5,986	9,21685	9,99402	9,22283	10,77717	31
31	1653	9862	1676	5,965	9,21836	9,99398	9,22438	10.77562	29
33	1659	9861	1682	5,943	9,21986	9,99393	9,22593	10.77407	27
35	1664	9860	1688	5,922	9,22181	9,99389	9,22747	10.77253	25
37	1670	9859	1694	5,902	9,22286	9,99385	9,22900	10.77099	23
39	1676	9858	1700	5,881	9,22435	9,99381	9,23053	10,76946	21
41	1682	9857	1706	5,860	9,22583	9,99376	9,23286	11.76793	19
43	1687	9856	1712	5,840	9,22731	9,99372	9,23358	10,76641	17
45	1693	9855	1718	5,819	9,22878	9,99368	9,23510	10,76489	15
47	1699	9854	1724	5,799	9,23025	9,99363	9,23661	10,76338	13
49	1704	9853	1730	5,779	9,23171	9,99359	9,23812	10,76188	11
51	1710	9852	1736	5,759	9,23317	9,99355	9,23963	10.76037	9
53	1716	9851	1742	5,739	9,23462	9,99350	9,24111	10,75888	7
55	1722	9849	1748	5,719	9,23607	9,99346	9,24261	10,75738	5
57	1727	9849	1754	5,700	9,23751	9,99341	9.24409	10,75590	3
59	1733	9848	1760	5,680	9,23895	9,99337	9 24588	10,75442	1
	C. S,	N.S.	C.T.	N. T.	co.sine	Log. *S.*	co. tan.	Log.tang.	M

80 Degrees.

10 Degrees,

M	N, si,		N, T,		Log, S,		Log, T.		
1	1739	9847	1766	5,661	9,24038	9,99332	9,24705	10,75294	59
3	1745	9846	1772	5,642	9,24181	9,99328	9,24853	10.75147	57
5	1750	9845	1778	5,623	9,24323	9,99324	9,24999	10.75000	55
7	1756	9844	1784	5,604	9,24465	9,99319	9,25196	10.74854	53
9	1762	9843	1790	5,585	9,24607	9,99315	9,25292	10,74708	51
11	1767	9842	1796	5.567	9,24747	9,99310	9,25437	10,74562	49
13	1773	9841	1802	5,548	9.24888	9,99306	9,25582	10,74417	47
15	1779	9840	1808	5,530	9,25028	9,99301	9,25727	10,74273	45
17	1785	9839	1814	5,511	9,25167	9,99296	9,25871	10,74129	43
19	1790	9838	1820	5.493	9,25306	9,99292	9,26014	10.73985	41
21	1796	9837	1826	5,475	9,25445	9,99287	9,26157	10,73842	39
23	1802	9836	1832	5,457	9,25553	9,99283	9,26300	10.73699	37
25	1808	9835	1838	5,439	9,25721	9,99278	9,26446	10,73557	35
27	1813	9834	1844	5,422	9,25858	9,99273	9,26584	10,73415	33
29	1819	9833	1850	5,404	9,25995	9,99268	9,26786	10.73274	31
31	1825	9832	1856	5,386	9,26131	9,99264	9,26867	10,73133	29
33	1830	9830	1862	5,369	9,26267	9.99259	9,27007	10,72992	27
35	1836	9829	1865	5,352	9,26402	9,99255	9,27148	10.72852	25
37	1842	9828	1874	5,334	9,26537	9.99250	9,27287	10.72714	23
39	1848	9827	1880	5,317	9,26672	9,99245	9.27427	10,72573	21
41	1853	9826	1886	5,301	9,26806	9,99241	9.27565	10,72434	19
43	1859	9825	1892	5,284	9,26940	9,99236	9.27704	10,72795	17
45	1865	9824	1898	5,267	9,27073	9,99231	9,27842	10,72157	15
47	1870	9823	1904	5,250	9,27206	9,99226	9,27980	10,72019	13
49	1876	9822	1910	5,233	9,27338	9,99221	9,28118	10,71882	11
51	1882	9821	1916	5,217	9,27471	9,99216	9,28254	10,71745	9
53	1888	9820	1922	5,201	9,27602	9,99211	9.28390	10,71609	7
55	1893	9819	1928	5,184	9.27733	9.99206	9,28526	10,71473	5
57	1899	9818	1934	5,168	9,27864	9.99202	9.28662	10,71337	3
59	1805	9816	1940	5,152	9,27999	9,99197	9.28797	10.71202	1
		N, si.		N, T,		Log, S,		Log, tang,	M

79 Degrees,

11 Degrees

M	N,si,		N,T,		Log. si,		Log.T,		
1	1911	9815	1946	5,136	9,28124	9.99192	9.28923	10.71067	59
3	1916	9814	1952	5.121	9.28254	9.99187	9,29067	10,70933	57
5	1922	9813	1958	5.105	9,28385	9,99182	9,29201	10,70798	55
7	1928	9812	1964	5,089	9,28512	9,99177	9,29335	10.70665	53
9	1933	9811	1970	5.073	9,28641	9,99172	9,29468	10.70532	51
11	1939	9810	1977	5,058	9.28768	9,99167	9,29601	10,70398	49
13	1945	9809	1983	5,042	9,28896	9,99162	9.29733	10,70266	47
15	1951	9808	1989	5.027	9,29023	9,99157	9.29866	10,70134	45
17	1956	9807	1995	5,012	9.29150	9,99152	9,29998	10,70002	43
19	1962	9805	2001	4,997	9,29276	9,99147	9,30132	10,69870	41
21	1968	9804	2007	4,982	9,29403	9,99142	9,30266	10.69739	39
23	1973	9803	2013	4,967	9,29528	9,99137	9,30391	10.69608	37
25	1979	9802	2019	4,952	9,29654	9,99132	9,30521	10.69478	35
27	1985	9801	2025	4,937	9,29778	9,99127	9,30652	10,69348	33
29	1990	9799	2031	4,922	9,29903	9,99122	9,30781	10,69218	31
31	1996	9798	2037	4,908	9,30027	9,99119	9,30911	10,69089	29
33	2002	9797	2043	4,893	9.30151	9,99111	9.31039	10.68960	27
35	2007	9796	2049	4.878	9.30274	9,99106	9.31168	10,68831	25
37	2013	9795	2055	4,864	9.30397	9,99101	9,31296	0,6870,	23
39	2019	9794	2061	4,850	9,30521	9,99096	9.31424	0,68575	21
41	2025	9792	2067	4,835	9,30643	9,99091	9,31552	10,68447	19
43	2030	9791	2073	4,821	9,30765	9.99085	9,31679	10.68320	17
45	20 6	9790	2080	4,807	9,30886	9,99080	9,,1806	10,68193	15
47	2042	9789	2086	4'793	9-31008	9.99075	9.31933	10.68.07	13
49	2047	9788	2092	4.779	9-31128	9,99069	9,32058	10.67941	11
51	2053	9786	2098	4,766	9,31249	9,99064	9,32185	10,67814	9
53	2059	9785	2105	4,752	9,31369	9,99059	9,32311	10.67656	7
55	2064	9784	2110	4,738	9,31489	9.99053	9,32437	10, 7564	5
57	2070	9 83	2116	4.725	9,31608	9,99048	9,32501	10,67439	3
59	20-6	9782	2122	4.711	9,31728	9.99043	9,,2685	10,67314	1
		N.S.		N,T,		Log, si,		Log,tang.	M

78 Degrees

12 Degrees,

M	N, si,		N, T,		Log, S,		Log, T.		
1	2081	9781	2128	4,699	9,31847	9,99037	9,32809	10,67190	59
3	2087	9779	2134	4,684	9,31965	9,99032	9,32933	10.67066	57
5	2093	9778	2140	4,671	9,32084	9,99027	9,33057	10.66943	55
7	2099	9777	2146	4,657	9,32203	9,99021	9,33180	10.66819	53
9	2104	9776	2152	4,649	9,32319	9,99016	9,33303	10,66796	51
11	2110	9774	2159	4,632	9,32436	9,99010	9,33426	10,66635	49
13	2116	9773	2168	4,618	9.32553	9,99005	9,33548	10,66452	47
15	2121	9772	2171	4,605	9,32670	9,98999	9,33670	10,66329	45
17	2127	9771	2177	4,592	9,32786	9,98994	9,33792	10,66208	43
19	2133	9769	2183	4.580	9,32902	9,98988	9.33913	10.66086	41
21	2138	9768	2189	4,567	9,33017	9,98983	9,34034	10,65965	39
23	2144	9767	2195	4,554	9,33132	9,98977	9,34155	10,65844	37
25	2150	9766	2201	4,542	9,33247	9,98972	9,34275	10,65729	35
27	2155	9764	2207	4,529	9,33362	9,98966	9,34395	10,65604	33
29	2161	9763	2213	4,516	9,33476	9,98960	9,34515	10.65484	31
31	2167	9762	2219	4,504	9.33591	9,98955	9,34635	10,65364	29
33	2172	9761	2226	4,492	9,33704	9.98949	9,34754	10,65245	27
35	2178	9759	2232	4,479	9,33817	9,98941	9,34873	10.65126	25
37	2184	9758	2238	4,467	9,33931	9,98938	9,34992	10.65007	23
39	2189	9757	2244	4,455	9.34043	9,98932	9.35110	10,64889	21
41	2195	9755	2250	4,443	9,34155	9,98927	9.35228	10,64771	19
43	2201	9754	2256	4.431	9,34267	9,98921	9.35346	10,64653	17
45	2206	9753	2262	4,419	9,34379	9,98915	9,35464	10,64536	15
47	2212	9752	2268	4.407	9,34491	9,98910	9,35581	10,64418	13
49	2218	9750	2275	4,395	9,34602	9,98904	9,35698	10,64302	11
51	2223	9749	2281	4,383	9,34713	9,98898	9.35815	10,64185	9
53	2229	9748	2287	4.372	9,34824	9,98892	9.35931	10,64063	7
55	2235	9747	2293	4,360	9.34930	9.98886	9,36047	10,63952	5
57	2241	9745	2299	4,348	9,35041	9.98881	9.36163	10,63836	3
59	2246	9744	2305	4,337	9,35154	9,98875	9.36278	10.63721	1
		N, si		N, T,		Log, S,		Log, tang,	M

77 Degrees,

13 Degrees.

M	N, fi.		N, T.		Log. S.		Log. T,		
1	2252	9743	2311	4,325	9,35263	9,98869	9,36394	10,63606	59
3	2258	9741	2317	4,314	9,35372	9,98863	9,36509	10,63491	57
5	2263	9740	2324	4,303	9,35481	9,98857	9,36623	10,63376	55
7	2269	9739	2330	4,291	9,35590	9,98852	9,36738	10,63261	53
9	2275	9737	2336	4,280	9,35698	9,98846	9,36852	10,63147	51
11	2280	9736	2342	4,269	9,35806	9,98840	9,36967	10,63033	49
13	2286	9735	2348	4,258	9,35914	9,98834	9,37081	10,62920	47
15	2292	9733	2354	4,246	9,36021	9,98828	9,37194	10,62806	45
17	2297	9732	2360	4,235	9,36128	9,98822	9,37306	10,62693	43
19	2303	9731	2366	4,224	9,36235	9,98816	9,37419	10,62580	41
21	2308	9729	2373	4,213	9,36342	9,98810	9,37532	10,62468	39
23	2314	9728	2379	4,203	9,36448	9,98804	9,37644	10,62355	37
25	2320	9727	2385	4,192	9,36554	9,98798	9,37756	10,62243	35
27	2325	9725	2391	4,181	9,36660	9,98792	9,37868	10,62131	33
29	2331	9724	2397	4,170	9,36766	9,98786	9,37979	10,62020	31
31	2337	9723	2403	4,160	9,36871	9,98780	9,38091	10,61909	29
33	2342	9721	2410	4,149	9,36976	9,98774	9,38202	10,61797	27
35	2348	9720	2416	4,138	9,37080	9,98767	9,38312	10,61687	25
37	2354	9718	2422	4,128	9,37185	9,98761	9,38423	10,61576	23
39	2359	9717	2428	4,117	9,37289	9,98755	9,38533	10,61466	21
41	2365	9716	2434	4,107	9,37393	9,98749	9,38643	11,61356	19
43	2371	9714	2440	4,097	9,37497	9,98743	9,38753	10,61246	17
45	2376	9713	2446	4,086	9,37600	9,98737	9,38863	10,61137	15
47	2382	9712	2453	4,076	9,37702	9,98731	9,38972	10,61027	13
49	2388	9710	2459	4,066	9,37806	9,98724	9,39081	10,60918	11
51	2393	9709	2465	4,055	9,37909	9,98718	9,39190	10,60809	9
53	2399	9707	2471	4,045	9,38011	9,98712	9,39298	10,60701	7
55	2405	9706	2477	4,035	9,38113	9,98706	9,39407	10,60592	5
57	2410	9705	2484	4,025	9,38215	9,98699	9,39518	10,60484	3
59	2416	9703	2490	4,015	9,38316	9,98693	9,39623	10,60376	1
	C, S,	N.S.	C.T	N, T.	co.fine	Log. *S.*	co. tan.	Log.tang.	M

76 Degrees.

14 Degrees,

M	N.si.		N,T,		Log. si.		Log,T.		
1	2422	9702	2496	4.005	9,38418	9,98687	9,39731	10,60269	59
3	2427	9700	2502	3,999	9,38519	9,98684	9,39838	10,60162	57
5	2433	9699	2508	3,986	9,38620	9,98674	9,39945	10.60054	55
7	2438	9695	2514	3,976	9,38720	9,98660	9,40052	10,59947	53
9	2444	9696	2521	3,966	9,38821	9,98662	9,40159	10,59841	51
11	2450	9696	2527	3,656	9,38921	9,98653	9,40268	10,59734	49
13	2455	9693	2533	3,947	9.39021	9,98649	9.40372	10,59628	47
15	2461	9692	2539	3,937	9,39121	9,98642	9,40477	10,59522	45
17	2467	9690	2545	3,927	9,39220	9,98636	9,40583	10,59416	43
19	2472	9689	2552	3,918	9,39319	9,98630	9,40689	10.59311	41
21	2478	9687	2558	3,908	9,39418	9,98623	9,40794	10,59205	39
23	2484	9686	2564	3,899	9,39516	9,98617	9,40899	10.59100	37
25	2489	9685	2570	3,890	9,39615	9,98610	9.41004	10,58995	35
27	2495	9683	2576	3,880	9,39713	9,98604	9,41109	10.58890	33
29	2500	9682	2583	3,871	9,39811	9,98597	9.41213	10,58786	31
31	2506	9680	2589	3,862	6,39908	9,98591	9,41318	10.58682	29
33	2512	9679	2595	3,852	9,40006	9,98584	9.41422	10.58578	27
35	2517	9677	2601	3.843	9.40103	9.98577	9.41525	10.58474	25
37	2523	9676	2607	3,834	9.40200	9.98571	9,41629	10.58370	23
39	2531	9674	2614	3,825	9,40291	9,98564	9.41732	10.58267	21
41	2534	9673	2620	3,816	9,40393	9,98558	9,41835	10,58164	19
43	2540	9671	2626	3,807	9,40490	9,98551	9,41938	10.58061	17
45	2546	9670	2632	3,798	9,40586	9.98544	9.42041	10.57958	15
47	2551	9668	2639	3,789	9,40682	9,98538	9,42144	10,57856	13
49	2557	9667	2645	3,780	9,40777	9,98531	9,42246	10,57753	11
51	2562	9666	2651	3,776	9,40873	9,98524	9,42346	10,57651	9
53	2568	9664	2657	3.762	9,40962	9,98518	9,42450	10,57549	7
55	2574	9663	2663	3.753	9,41063	9,98511	9,42552	10,57448	5
57	2579	9661	2670	3,745	9,41158	9,98504	9,42653	10,57346	3
59	2585	9660	2676	3,736	9,41252	9,98497	6,42754	10.57245	1
		N,si.		N,T		Log, si.		Log.tang,	M

75 Degrees

15 Degrees

M	N,si,		N,T,		Log. si,		Log.T,		
1	2591	9658	2682	3,727	9,41346	9.98494	9.42855	10.57144	59
3	2596	9656	2688	3,719	9.41440	9.98484	9,42956	10,57043	57
5	2602	9655	2695	3.710	9,41534	9,98477	9,43057	10,56942	55
7	2607	9653	2701	3,701	9,41628	9,98470	9,43157	10.56842	53
9	2613	9652	2707	3,693	9,41721	9,98463	9,43258	10.56742	51
11	2619	9650	2713	3,684	9.41814	9,98456	9,43358	10,56642	49
13	2624	9649	2720	3,676	9,41907	9,98450	9.43458	10,56542	47
15	2630	9647	2726	3.665	9,42000	9,98443	9.43557	10,56442	45
17	2635	9646	2732	3.659	9.42093	9,98436	9,43657	10,56343	43
19	2641	9644	2738	3.651	9,42185	9,98429	9,43756	10,56243	41
21	2647	9643	2745	3,642	9,42277	9,98422	9.43855	10.56144	39
23	2652	9641	2751	3.634	9,42369	9,98415	9.43904	10.56045	37
25	2658	9640	2757	3,626	9,42461	9,98408	9,44053	10.55947	35
27	2663	9638	2763	3,618	9,42553	9,98401	9.44151	10,55848	33
29	2669	9637	2770	3,609	9,42644	9,98394	9,44249	10.55750	31
31	2675	9635	2776	3,601	9,42735	9,98387	9,44347	10,55652	29
33	2680	9633	2782	3,593	9.42826	9,98380	9,44445	10.55554	27
35	2689	9632	2788	3,585	9.42917	9,98373	9,44543	10,55456	25
37	2692	9630	2795	3,577	9.43007	9,98366	9,44641	10,55358	23
39	2697	9629	2801	3,569	9,43097	9,98359	9,44738	10,55261	21
41	2703	9627	2807	3,561	9,43187	9,98352	9,44835	10,55164	19
43	2708	9626	2814	3,558	9,43277	9.98345	9,44932	10.55067	17
45	2714	9624	2820	3.545	9,43367	9,98338	9,45029	10,54970	15
47	2720	9622	2826	3.537	9.43457	9,98331	9.45126	10.54874	13
49	2725	9021	2832	3°530	9.43546	9,98323	9,45222	10.54777	11
51	2731	9619	2839	3°522	9.43635	9,98316	9,45318	10,54681	9
53	2736	9618	2845	3,514	9,43724	9,98309	9,45414	10,54585	7
55	2742	9616	2851	3,506	9,43813	9.98302	9,45510	10,54489	5
57	2747	9615	2858	3.498	9,43901	9,98295	9,45606	10,54393	3
59	2753	9613	2864	3,491	9,43989	9.98287	9,45702	10.54298	1
		N.S.		N,T,		Log, si,		Log,tang.	M

74 Degrees

16 Degrees.

M	N.fi.		N, T,		Log. fi.		Log. T.		
1	2759	9611	2870	3,483	9,44077	9,98280	9,45797	10,54202	59
3	2764	9610	2876	3,475	9,44165	9,98273	9,45892	10,54107	57
5	2770	9608	2883	3,466	9,44252	9,98266	9,45987	10,54012	55
7	2775	9606	2889	3,460	9,44341	9,98258	9,46082	10,53917	53
9	2781	9605	2895	3,45	9,44428	9,98251	9,46177	10,53823	51
11	2787	9603	2902	3,445	9,44515	9,98244	9,46271	10,53728	49
13	2792	9602	2908	3,438	9,44602	9,98236	9,46365	10,53633	47
15	2798	9600	2914	3,431	9,44689	9,98229	9,46460	10,53540	45
17	2803	9598	2921	3,423	9,44776	9,98222	9,46554	10,53446	43
19	2809	9597	2927	3,416	9,44862	9,98214	9,46647	10,53352	41
21	2815	9595	2933	3,408	9,44948	9,98207	9,46741	10,53258	39
23	2820	9593	2939	3,401	9,45034	9,98199	9,46834	10,53165	37
25	2826	9592	2946	3,394	9,45120	9,98192	9,46928	10,53072	35
27	2831	9590	2952	3,386	9,45206	9,98184	9,47021	10,52978	33
29	2837	9589	2958	3,379	9,45291	9,98177	9,47114	10,52885	31
31	2842	9587	2965	3,372	9,45376	9,98170	9,47206	10,52793	29
33	2848	9585	2971	3,365	9,45461	9,98162	9,47299	10,52700	27
35	2854	9584	2977	3,358	9,45546	9,98154	9,47392	10,52608	25
37	2859	9582	2984	3,350	9,45631	9,98147	9,47484	10,52515	23
39	2865	9580	2990	3,343	9,45716	9,98140	9,47579	10,52423	21
41	2870	9579	2996	3,336	9,45800	9,98132	9,47668	10,52331	19
43	2876	9577	3003	3,329	9,45884	9,98124	9,47760	10,52240	17
45	2881	9575	3009	3,322	9,45968	9,98117	9,47851	10,52148	15
47	2887	9574	3016	3,315	9,46052	9,98109	9,47943	10,52056	13
49	2893	9572	3022	3,308	9,46136	9,98102	9,48034	10,51965	11
51	2898	9570	3028	3,301	9,46220	9,98094	9,48125	10,51874	9
53	2904	9569	3035	3,294	9,46303	9,98086	9,48216	10,51783	7
55	2909	9567	3041	3,287	9,46386	9,98078	9,48307	10,51692	5
57	2915	9565	3047	3,281	9,46469	9,98071	9,48398	0,51601	3
59	2920	9563	3054	3,27	9,46555	9,98063	6,48488	10,51511	1
		N,fi.		N,T		Log, fi.		Log.tang,	M

73 Degrees

17 Degrees.

M	N, S.		N.T.		Log. S.		Log. T.		
1	2926	9562	3060	3,267	9,46634	9,98055	9,48579	10,51421	59
3	2932	9560	3066	3,260	9,46717	9,98048	9,48666	10,51330	57
5	2937	9558	3073	3,253	9,46799	9,98040	9,48759	10,51240	55
7	2943	9557	3079	3,247	9,46881	9,98032	9,48845	10,51150	53
9	2948	9555	3085	3,240	9,46963	9,98021	9,48939	10,51061	51
11	2954	9553	3092	3,233	9,47045	9,98016	9,49028	10,50971	49
13	2959	9552	3098	3,227	9,47127	9,98009	9,49118	10,50882	47
15	2965	9550	3105	3,220	9,47208	9,98001	9,49207	10,50792	45
17	2970	9548	3111	3,214	9,47289	9,97993	9,49296	10,50703	43
19	2976	9546	3117	3,207	9,47371	9,97985	9,49385	10,50614	41
21	2982	9545	3124	3,200	9,47452	9,97977	9,49474	10,50525	39
23	2987	9543	3130	3,194	9,47532	9,97969	9,49563	10,50437	37
25	2993	9541	3137	3,187	9,47613	9,97961	9,49651	10,50348	35
27	2998	9539	3143	3,181	9,47693	9,97954	9,49740	10,50260	33
29	3004	9538	3149	3,175	9,47774	9,97946	9,49828	10,50171	31
31	3009	9536	3156	3,168	9,47854	9,97938	9,49916	10,50083	29
33	3015	9534	3162	3,162	9,47934	9,97930	9,50004	10,49995	27
35	3020	9532	3168	3,155	9,48014	9,97922	9,50092	10,49908	25
37	3026	9531	3175	3,149	9,48093	9,97914	9,50179	10,49820	23
39	3032	9529	3181	3,142	9,48173	9,97906	9,50267	10,49731	21
41	3037	9527	3188	3,136	9,48252	9,97898	9,50354	11,49645	19
43	3043	9525	3194	3,130	9,48331	9,97889	9,50441	10,49558	17
45	3048	9523	3201	3,124	9,48410	9,97881	9,50528	10,49471	15
47	3054	9522	3207	3,117	9,48489	9,97873	9,50616	10,49384	13
49	3059	9520	3213	3,111	9,48568	9,97865	9,50703	10,49297	11
51	3065	9518	3220	3,105	9,48647	9,97857	9,50789	10,49210	9
53	3070	9516	3226	3,099	9,48725	9,97849	9,50876	10,49124	7
55	3076	9515	3233	3,092	9,48803	9,97841	9,50962	10,49037	5
57	3081	9513	3239	3,086	9,48881	9,97832	9,51048	10,48951	3
59	3087	9511	3245	3,080	9,48959	9,97824	9,51134	10,48865	1
	C. S.	N.S.	C.T.	N. T.	co.sine	Log. S.	co. tan.	Log.tang.	M

72 Degrees.

18 Degrees,

M	N, fi,		N.T.		Log ,S,		Log,T.		
1	3092	9509	3255	3,074	9,49037	9,97816	9,51220	10,48779	59
3	3098	9507	3258	3,068	9,49114	9,97808	9,51306	10,48693	57
5	3103	9506	3265	3,062	9,49192	9,97800	9,51392	10,48608	55
7	3109	9504	3271	3,056	9,49270	9,97792	9,51431	10,48522	53
9	3115	9502	3278	3,050	9,49346	9,9778	9,51563	10,48437	51
11	3120	9500	3284	3,044	9,49423	9,97778	9,51648	10,48351	49
13	3126	9498	3291	3,038	9,49500	9,97760	9,51733	10,48266	47
15	3131	9496	3297	3,032	9,49577	9,97758	9,51818	10,48181	45
17	3137	9495	3305	3,026	9,49653	9,97750	9,51903	10,48096	43
19	3142	949	3310	3,020	9,49730	9,97742	9,51988	10 48011	41
2	3148	9491	3316	3,014	9,49806	9,97733	9,52072	10,47927	39
23	3153	9489	3323	3,009	9,49882	9,97725	9,52157	10,47842	37
2	3159	9487	3329	3,003	9,49958	9,97716	9,52241	10,47778	35
27	3164	9486	3336	2,997	9,50034	9,97708	9,52326	10,47674	33
29	3173	9484	3342	2,991	9,50109	9,97699	9,52410	10.47590	31
3	3175	9482	3349	2,985	9,50188	9,97691	9,52493	10,47500	29
33	3181	9480	3355	2,980	9,50260	9,97683	9,52577	10,47422	27
35	3186	9478	3362	2,974	9,50336	9,97674	9,52661	10.47338	25
37	3192	9476	3368	2,963	9,50411	9,97666	9,52745	10.47255	23
39	3197	9474	3375	2,962	9,50486	9,97657	9.52828	10,47171	21
41	3203	9473	3381	2.957	9,50560	9,97648	9.52912	10,47088	19
43	3208	9471	3388	2,951	9,50635	9,97640	9.52995	10,47005	17
45	3214	9469	3394	2,946	9,50709	9,97631	9,53078	10,46922	15
47	3219	9467	3401	2,940	9.50784	9,97623	9,53161	10,46889	13
49	3225	9465	3407	2.934	9,50858	9,97614	9,53244	10,46786	11
51	3230	9463	3414	2,929	9,50932	9,97606	9.53332	10,46673	9
53	236	9461	3420	2,923	9,51006	9,97597	9.53409	10,46591	7
55	3241	9459	3427	2,918	9.51080	9.97588	9,53491	10,46508	5
57	3247	9458	3433	2.912	9,51154	9.97580	9.53574	10,46426	3
59	252	9456	3440	2,907	9,51227	9,97573	9.53656	10.46344	1
		N. fi		N,T.		Log, S,		Log,tang,	M

71 Degrees,

19 Degrees

M	N,fi,		N,T,		Log. fi,		Log,T,		
1	3258	9454	3446	2,901	9,51300	9.97562	9.53738	10.46261	60
3	3265	9452	3453	2.898	9.51374	9.97552	9,53820	10,46179	57
5	3269	9450	3459	2,896	9.5144?	9,97545	9,5 902	0,46098	55
7	3274	9448	3466	2.885	9.51520	9,97536	9,53983	0.46016	53
9	3280	9446	3472	2.879	9,5159?	9,97527	9,54065	10.45934	51
11	3285	9444	3479	2.873	9.51665	9,97518	9,5414?	10,45853	49
13	3291	9442	3485	2,869	,51738	9.97510	9.54228	10,45772	47
15	3296	9441	3492	2,865	9,51810	9,97501	9.54309	0,45650	45
17	3302	9438	3498	2,858	9,51884	9,97492	9,54390	10,45609	43
19	3307	9437	3505	2,852	9,51955	9,97483	9,5447	10,45528	41
21	3313	9435	3511	2,847	9,52027	9,97474	9 54552	10.45447	39
23	3318	9433	3518	2,842	9,52099	9,97466	9.5 633	0.45366	37
25	3324	9431	3525	2,837	9,52170	9,97457	9,5471?	10.45286	35
27	3329	9429	3531	2,831	9,52242	9,97448	9.54794	0,45205	33
29	3335	9427	3537	2,820	9,52313	9,97439	9,54874	10,45125	31
31	3341	9425	3544	2,821	9,52385	9,97430	9,54955	10,45040	29
33	3346	9423	3551	2,816	9.52456	9,97421	9,55035	10.44964	27
35	3351	9421	3557	2.811	9.52527	9,97412	9,55115	0,44884	25
37	3357	9419	3564	,800	9.52598	9,97403	9,55195	0,44804	23
39	3362	9417	3570	2,797	9,52669	9,97394	9,55275	0,44725	21
41	3368	9415	3577	2,795	9,52740	9,97385	9,55354	10,44645	19
43	3373	9413	3583	2,798	9,52810	9.97376	9,55434	10.44565	17
45	3379	9411	3590	2,785	9,52881	9,97367	9,55513	0,44486	15
47	3384	9409	3596	2,780	9.52951	9.97358	9.555 3	10.44406	13
49	3390	9407	3603	2.775	9.53021	9,97348	9.55672	10.44327	11
51	3395	9405	3610	2,770	9,53091	9,97339	9.55751	10,44248	9
53	3401	9403	3616	2,765	9,53161	9,97330	9,55830	0,44169	7
55	3406	9401	3623	2,759	9,53231	9.97321	9,55909	10,44090	5
57	3412	9399	3629	2,755	9,53301	9,97312	9,55988	10,44011	3
59	3418	9397	3636	2,750	9,53370	9,97303	9,56067	10.43932	1
		N.S.		N,T,		Log, fi,		Log,tang.	M

70 Degrees

20 Degrees.

M	N.fi.		N,T,		Log. fi.		Log.T.		
1	3422	9395	3642	2,744	9,53445	9,97294	9,56145	10,43854	59
3	3428	9393	3649	2,740	9,53509	9,97284	9,56224	10,43775	57
5	3433	9391	3656	2,735	9,53578	9,97284	9,56302	10,43697	55
7	3439	9389	3662	2,730	9,53647	9,97274	9,56381	10,43619	53
9	3444	9387	3669	2,725	9,53716	9,97257	9,56450	10,43541	51
11	3450	9385	3673	2,720	9,53785	9,97247	9,56537	10,43462	49
13	3455	9383	3682	2,715	9,53883	9,97238	9,56615	10,43384	47
15	3460	9381	3689	2,710	9,53922	9,97229	9,56693	10,43306	45
17	3466	9379	3695	2,705	9,53990	9,97219	9,56771	10,43229	43
19	3472	9377	3702	2,700	9,54059	9,97210	9,56848	10,43151	41
21	3477	9375	3709	2,696	9,54127	9,97201	9,56926	10,43074	39
23	3482	9373	3715	2,691	9,54195	9,97195	9,57003	10,42996	37
25	3488	9371	3722	2,686	9,54263	9,97182	9,57081	10,42919	35
27	3493	9369	3728	2,681	9,54331	9,97173	9,57158	10,42842	33
29	3499	9367	3735	2,676	9,54398	9,97162	9,57235	10,42765	31
31	3504	9365	3742	2,672	9,54466	9,97154	9,57342	10,42687	29
33	3510	9363	3748	2,667	9,54533	9,97144	9,57388	10,42611	27
35	3515	9361	3755	2,662	9,54601	9,97135	9,57466	10,42534	25
37	3521	9359	3762	2,658	9,54668	9,97125	9,57542	10,42457	23
39	3526	9357	3768	2,653	9,54781	9,97116	9,57619	10,42381	21
41	3532	9355	3775	2,648	9,54802	9,97106	9,57695	10,42304	19
43	3537	9353	3782	2,644	9,54866	9,97097	9,57772	10,42227	17
45	3542	9351	3788	2,639	9,54939	9,97087	9,57848	10,42151	15
47	3548	9349	3795	2,634	9,55002	9,97078	9,57924	10,42075	13
49	3553	9347	3801	2,630	9,55069	9,97068	9,58000	10,42999	11
51	3559	9345	3808	2,625	9,55135	9,97058	9,58076	10,41923	9
53	3564	9343	3815	2,621	9,55262	9,97049	9,58152	10,41847	7
55	3570	9341	3821	2,616	9,55268	9,97039	9,58228	10,41771	5
57	3575	9338	3828	2,611	9,55334	9,97029	9,58304	10,41695	3
59	3580	9336	3831	2,607	9,55406	9,97020	6,58380	10,41620	1
		N,fi.		N,T		Log, fi.		Log.tang,	M

69 Degrees

21 Degrees.

M	N, fi.		N.T.		Log. S.		Log. T.		
1	3586	9334	3841	2,602	9,55465	9,97010	9,58456	10,41544	59
	3591	9332	3848	2,598	9,55531	9,97000	9,58531	10,41469	57
	3597	9330	3855	2,593	9,55597	9,96990	9,58606	10.41393	55
7	3602	9328	3862	2,589	9,55662	9,96981	9.58681	10,41318	53
9	3608	9326	3868	2,584	9,55728	9,96971	9,58756	10,41242	51
11	3613	9324	3875	2,580	9,55793	9,96961	9,5883	0,41168	49
13	3618	9322	3882	2,576	9,55858	9.96951	9,58906	10.41093	47
15	3624	9320	3888	2,571	9,55923	9 9694	9,58981	10,41018	45
17	3629	9317	3895	2,567	9.5 988	9,96942	9.59056	10.40944	43
19	3635	9315	3902	2,562	9.56053	9.96922	9,59131	10.40869	41
21	3640	9313	3908	2,588	9,56117	9,96912	9,59205	1.40794	39
23	3646	9311	3915	2,553	9.56182	9,96902	9,59279	0,40720	37
25	3651	9309	3922	2,549	9,56246	9,96892	9,59354	0,40645	35
27	3656	9307	3929	2,545	9,56311	9,96882	9,59428	10,40577	33
29	3662	9305	3935	2,540	9,56375	9,96872	9,59502	10,40497	31
31	3667	9303	3942	2,536	9,56439	9,96862	9,59576	10 40423	29
33	3673	9301	3949	2,532	9,56503	9,96852	9,59651	10,40349	27
35	3678	9298	3955	2,527	9,56567	9,96843	9,59724	10,40275	25
37	3683	9296	3962	2,523	9,56631	9.96832	9,59798	0,40201	23
39	3688	9294	3969	2,519	9,56695	9.96822	9,59872	10,40127	21
41	3694	9292	3976	2,515	9,56758	9,96812	9,59946	10.40054	19
43	3700	9290	3982	2,508	9,56822	9,96802	9,60019	10.39980	17
45	3705	9288	3989	2,506	9,56885	9,96792	9,60093	10,39907	15
47	3710	9285	3996	2,502	9,56948	9.96782	9.60166	10,39833	13
49	3716	9283	4003	2,498	9,57012	9,96772	9 60239	10.39760	11
51	3721	9281	4009	2,493	9,57075	9,96762	9,60312	10.39687	9
53	3726	9279	4016	2,489	9,57138	9,96752	9,60385	10.39614	7
55	3732	9277	4023	2,485	9,57201	9,96742	9,60458	10.39541	5
57	3737	9275	4030	2,481	9,57263	9,96732	9,60531	10,39468	3
59	3743	9272	4036	2,477	9,57326	9,96721	9,60604	0.39395	1
	C, S,	N.S.	C.T	N. T.	co.fine	Log. S.	co. tan.	Log.tang.	M

68 Degrees.

22 Degrees.

M	N, si,		N.T.		Log, S,		Log, T.		
1	3748	9270	4043	2,473	9,57388	9,96711	9,60677	10,39322	59
3	3754	9268	4050	2,468	9,57451	9,96701	9,60750	10,39250	57
5	3759	9266	4057	2,464	9,57513	9,96691	9,60822	10,39177	55
7	3764	9264	4063	2,460	9,57583	9,96680	9,60895	10,39105	53
9	3770	9262	4070	2,456	9,57638	9,96670	9,60967	10,39032	51
11	3775	9259	4077	2,452	9,57700	9,96660	9,61039	10,38960	49
13	3781	9257	4084	2,448	9,57761	9,96650	9,61111	10,38888	47
15	3786	9255	4091	2,444	9,57823	9,96639	9,61184	10,38816	45
17	3791	9253	4097	2,440	9,57885	9,96629	9,61256	10,38743	43
19	3797	9250	4104	2,436	9,57946	9,96618	9,61328	10,38671	41
21	3802	9248	4111	2,432	9,58008	9,96608	9,61400	10,38660	39
23	3808	9246	4118	2,428	9,58070	9,96598	9,61472	10,38528	37
25	3813	9244	4125	2,424	9,58131	9,96587	9,61543	10,38456	35
27	3818	9242	4131	2,420	9,58192	9,96577	9,61615	10,38385	33
29	3824	9239	4138	2,416	9,58253	9,96566	9,61686	10,38313	31
31	3829	9237	4145	2,412	9,58314	9,96556	9,61758	10,38241	29
33	3834	9235	4152	2,408	9,58375	9,96545	9,61829	10,38170	27
35	3840	9233	4159	2,404	9,58436	9,96535	9,61900	10 38099	25
37	3845	9230	4166	2,400	9,58497	9,96524	9,61973	10.38028	23
39	3851	9228	4172	2,396	9,58557	9,96514	9.62043	10,37956	21
41	3856	9226	4179	2,392	9,58618	9,96503	9,62114	10,37885	19
43	3861	9224	4186	2,388	9,58678	9,96493	9 62185	10,37814	17
45	3867	9222	4193	2,384	9,58738	9,96482	9,62256	10,37744	15
47	3872	9219	4200	2,380	9,58798	9,96472	9,62327	10,37673	13
49	3877	9217	4207	2,376	9,58859	9,96461	9,62397	10,37602	11
51	3883	9215	4213	2,373	9,58919	9,96450	9,62468	10,37531	9
53	3888	9212	4220	2,369	9,58976	9,96440	9.62538	10,37461	7
55	3893	9210	4227	2,365	9,59038	9,96429	9.62609	10,37390	5
57	3899	9208	4234	2,361	9,59098	9,96418	9,62679	10,37320	3
59	3904	9206	4241	2,357	9,59158	,996408	9,62750	10.37250	1
		N. si		N,T.		Log. si.		Log,tang,	M

67 Degrees

23 Degrees

M	N,si,		N,T,		Log. si,		Log.T,		
1	3909	9203	4248	2,354	9,59217	9.96397	9.62820	10.37179	59
3	3915	9201	4255	2.350	9.59277	9.96386	9,62890	10,37109	57
5	3920	9199	4261	2,346	9,59336	9,96375	9,62960	10,37039	55
7	3926	9197	4268	2,342	9,59395	9,96365	9,63030	10.36969	53
9	3931	9194	4275	2,339	9,59434	9,96354	9,63100	10.36899	51
11	3936	9192	4282	2.335	9.59513	9,96343	9,63170	10,36829	49
13	3942	9190	4289	2,331	9,59572	9,96332	9.63240	10,36759	47
15	3947	9187	4296	2,327	9,59631	9,96321	9.63309	10,36690	45
17	3952	9185	4303	2,323	9.59690	9,96310	9,63379	10,36620	43
19	3958	9182	4310	2,320	9,59740	9,96300	9,63449	10,36551	41
21	3963	9181	4317	2,316	9,59897	9,96289	9.63518	10.36481	39
23	3968	9178	4323	2,312	9,59866	9,96278	9.63587	10.36412	37
25	3974	9176	4330	2,309	9,59924	9,96267	9,63657	10.36342	35
27	3979	9174	4337	2,305	9,59982	9,96256	9.63726	10,36273	33
29	3984	9171	4344	2,301	9,60041	9,96245	9,63795	10.36204	31
31	3990	9169	4351	2,298	9,60099	9,96234	9,63864	10,36138	29
33	3995	9167	4358	2,294	9.60157	9,96223	9,63933	10.36066	27
35	4000	9164	4365	2.290	9.60215	9,96215	9,64002	10,35997	25
37	4006	9162	4372	2,287	9.60272	9,96201	9,64071	10,35928	23
39	4011	9160	4379	2,283	9,60330	9,96190	9,64140	10,35859	21
41	4016	9157	4386	2,279	9,60388	9,96179	9,64209	10,35790	19
43	4022	9155	4393	2,276	9,60445	9.96168	9,64277	10.35722	17
45	4027	9153	4400	2,272	9.60503	9,96156	9,64346	10,35653	15
47	4032	9150	4407	2,269	9.60560	9.96148	9.64414	10.35585	13
49	4040	9148	4414	2.265	9.60618	9,96134	9,64483	10.35516	11
51	4043	9146	4420	2.262	9,60675	9,96123	9,64551	10,35448	9
53	4048	9143	4427	2,258	9,60723	9,96112	9,64620	10,35380	7
55	4054	9141	4434	2,254	9,60789	9.96101	9,64688	10,35312	5
57	4059	9139	4441	2,251	9,60846	9,96089	9,64756	10,35293	3
59	4064	9136	4448	2,247	9,60903	9.96078	9,64824	10.35175	1
		N.S.		N,T,		Log, si,		Log,tang.	M

66 Degrees

24 Degrees.

M	N, si,		N, T,		Log, S,		Log, T.		
1	4070	9134	+455	2,244	9.60959	9,96067	9,64892	10,35107	59
3	4075	9131	+462	2,240	9,61016	9,96056	9,64960	10,35039	57
5	4080	9129	+469	2,237	9,61073	9,96044	9,65028	10,34972	55
7	4085	9127	+476	2,233	9,61128	9,96033	9,65096	10.34904	53
9	4091	9124	+483	2,230	9,61185	9,96022	9,65163	10.34836	51
11	4096	9122	+490	2,226	9,61242	9,96011	9,65231	10.34768	49
13	4101	9120	+497	2,223	9,61298	9,95999	9,65298	10.34701	47
15	4107	9117	+504	2,220	9,61354	9,95988	9,65366	10,34633	45
17	4112	9115	+511	2,216	9,61410	9,95970	9,65433	10,34566	43
19	4117	9112	+518	2,213	9,61466	9,95965	9,65501	10.34499	41
21	4123	9110	+525	2,209	9,61522	9,95953	9,65568	10,34431	39
23	4128	9108	+532	2,206	9,61578	9,95942	9,65635	10.34364	37
25	4135	9105	+539	2,202	9,61633	9,95931	9,65702	10.34297	35
27	4138	9103	+546	2,199	9,61689	9,95919	9,65769	10,34230	33
29	4144	9100	+553	2,195	9,61748	9,95908	9,65837	10,34163	31
31	4149	9098	+560	2,192	9,61803	9,95896	9,65903	10.34096	29
33	4154	9095	+567	2,189	9,61858	9,95885	9,65970	10,34029	27
35	4160	9093	+574	2,185	9,61911	9,95873	9,66037	10,33962	25
37	4165	9091	+581	2,182	9,61966	9,95862	9,66104	10,33895	23
39	4170	9088	+588	2,179	9,62021	9,95850	9,66171	10,33829	21
41	4176	9086	+595	2,175	9,62076	9,95838	9,66237	10,33762	19
43	4181	9083	+603	2,172	9,62131	9,95827	9,66304	10,33695	17
45	4186	9081	+610	2,169	9,62186	9,95815	9,66370	10,33629	15
47	4191	9078	+617	2,165	9,62241	9,95803	9,66437	10.33596	13
49	4197	9076	+624	2,162	9,62295	9,95792	9,66503	10,33496	11
51	4202	9074	+631	2,159	9,62350	9,95780	9,66569	10,33430	9
53	4207	9071	+638	2,156	9,62404	9,95768	9,66636	10,33364	7
55	4212	9069	+645	2,152	9,62459	9,95757	9,66702	10,33297	5
57	4218	9066	+652	2,149	9,62513	9,95745	9,66768	10,33231	3
59	4223	9064	+659	2,146	9,62567	,995783	9,66834	10,33165	1
		N, si.		N, T.		Log. si.		Log, tang,	M

65 Degrees

25 Degrees.

M	N, fi.		N.T,		Log. S.		Log. T,		
1	4228	9061	4666	2,142	9,62622	9,95721	9,66900	10,33099	59
3	4234	9059	4673	2,139	9,62676	9,95710	9,66966	10,33034	57
5	4239	9056	4680	2,136	9,62730	9,95698	9,67032	10.32968	55
7	4244	9054	4687	2,133	9,62784	9,95686	9.67097	10,32902	53
9	4249	9051	4694	2,129	9,62837	9,95674	9.67164	10,32836	51
11	4253	9049	4702	2,126	9,62891	9,95662	9,67229	10,32771	49
13	4260	9047	4709	2,123	9,62945	9.95650	9,67292	10.32705	47
15	4265	9044	4716	2,120	9,62998	9.95638	9,67360	10.32639	45
17	4272	9042	4723	2,117	9,63052	9,95626	9,67425	10.32574	43
19	4276	9039	4730	2,113	9,63106	9.95614	9,67491	10.32509	41
21	4281	9037	4737	2,110	9,63159	9,95603	9,67556	11.32443	39
23	4286	9034	4744	2,107	9,63212	9,95591	9,67621	10,32378	37
25	4291	9032	4751	2,104	9,63265	9,95578	9,67686	10,32313	35
27	4297	9029	4759	2,101	9,63319	9,95567	9,67752	10,32248	33
29	4302	9027	4766	2,098	9,63372	9,95554	9,67817	10,32183	31
31	4307	9024	4773	2,095	9,63425	9,95542	9,67882	10.32118	29
33	4312	9022	4780	2,091	9,63477	9,95530	9,67947	10,32053	27
35	4318	9019	4787	2,088	9,63530	9,95518	9,68012	10,31988	25
37	4323	9017	4794	2,085	9,63583	9.95506	9,68076	10,31923	23
39	4328	9014	4801	2,082	9,63636	9.95495	9,68141	10,31856	21
41	4333	9012	4809	2,079	9,63688	9,95482	9,68206	10.31793	19
43	4339	9009	4816	2,076	9,63741	9.95470	9,68271	10.31729	17
45	4344	9006	4823	2,073	9,63793	9,95457	9,68335	10,31664	15
47	4349	9004	4830	2,071	9,63845	9.95445	9,68400	10,31600	13
49	4354	9001	4837	2,067	9,63898	9,95433	9,68464	10.31535	11
51	4360	8999	4844	2,064	9,63950	9,95421	9,68526	10.31471	9
53	4365	9996	4852	2,061	9,64002	9,95409	9,68593	10.31406	7
55	4370	9994	4859	2,057	9,64054	9,95396	9,68657	10.31342	5
57	4375	9991	4866	2,054	9,64106	9,95384	9,68722	10,31278	3
59	4381	9986	4873	2,051	9,64158	9,95372	9,68786	10.31214	1
	C, S,	N.S.	C.T.	N, T.	co. fine	Log, *S.*	co. tan.	Log.tang.	M

64 Degrees.

26 Degrees,

M	N.si.		N,T,		Log. si.		Log.T.		
1	4386	8986	4880	2,058	9,64210	9,95359	9,68850	10,31149	59
3	4391	8984	4888	2,055	9,64261	9,95347	9,68914	10,31035	57
5	4396	8981	4895	2,052	9,64313	9,95335	9,68970	10,31021	55
7	4402	8978	4902	2,049	9,64361	9,95322	9,69042	10,30957	53
9	4407	8976	4909	2,046	9,64416	9,95310	9,69106	10.30893	51
11	4412	8973	4916	2,043	9,64468	9,95298	9,69170	10,30830	49
13	4417	8971	4924	2,040	9,64519	9,95285	9,69202	10,30766	47
15	4422	8968	4931	2,037	9,66570	9,95273	9,69297	10.30702	45
17	4428	8966	4938	2,034	9,64621	9,95260	9,69361	10,30638	43
19	4433	8963	4945	2,031	9,64673	9,95248	9,69424	10,30575	41
21	4438	8960	4953	2,029	9,64734	9,95235	9.69488	10.30511	39
23	4443	8953	4960	2,026	9,64775	9.95223	9.69551	10.30448	37
25	4448	8955	4967	2,023	9,64825	9.95211	9,69615	10.30384	35
27	4454	8951	4974	2,020	9,64876	9,95198	9.69678	10.30321	33
29	4458	8950	4982	2,007	9,64927	9,95184	9.69743	10.30258	31
31	4464	8948	4989	2,004	9,64978	9,95172	9,69805	10,30194	29
33	4469	8945	4996	2,001	9,65028	9,95168	9.69868	10.30131	27
35	4474	8942	5003	1,998	9,65079	9,95147	9,69931	10,30068	25
37	4480	8940	5011	1,995	9,65129	9,95135	9,69994	10.30005	23
39	4485	8937	5018	1,992	9,65180	9,95122	9,70057	10.29947	21
41	4490	8935	5025	1,980	9,65230	9,95109	9,70120	10,29879	19
43	4495	8932	5033	1,986	9,65280	9,95096	9,70183	10,29816	17
45	4500	8929	5044	1,984	9,65330	9,95084	9,70246	10,29753	15
47	4506	8927	5047	1,981	9,65380	9,95071	6,70309	10.29690	13
49	4511	8924	5055	1,978	9,65431	9,95058	9,70372	10,29627	11
51	4516	8921	5066	1,975	9,65480	9,95045	9,70435	10,29565	9
53	4521	8919	5069	1,972	9,65530	9,95033	9.70497	10.29502	7
55	4526	8916	5076	1,969	9,65580	9,95020	9,70560	10,29439	5
57	4532	8914	5084	1,966	9,65630	9,95007	9,70622	10.29377	3
59	4537	8911	5091	1,964	9,65680	9.94988	9,70685	10.29314	1
		N,si.		N,T		Log, si.		Log.tang,	M

63 Degrees

27 Degrees

M	N,si,		N,T,		Log. si,		Log.T,		
1	4542	8908	5098	1,961	9,65726	9.94981	9.70747	10,29252	59
3	4547	8906	5106	1,958	9,65774	9.94968	9.70810	10,29189	57
5	4552	8903	5113	1,955	9.65828	9,94955	9,70872	10,29127	55
7	4558	8900	5120	1,952	9,65877	9,94943	9,70934	10,29065	53
9	4563	8898	5128	1,950	9,65927	9,94930	9,70997	10,29003	51
11	4568	8895	5135	1,947	9,65976	9,94917	9,71059	0.28940	49
13	4573	8892	5142	1,944	9,66025	9,94904	9,71121	10,28878	47
15	4578	8890	5150	1,941	9.66074	9,94891	9.71183	10,28816	45
17	4583	8885	5137	1,938	9,66123	9,94878	9,71245	10.28754	43
19	4589	8884	5165	1,936	9.66172	9,94865	9,71307	10.28692	41
21	4594	8882	5172	1,933	9,66221	9,94852	9.71369	10,28630	39
23	4599	8879	5179	1,930	9,66270	9,94838	9.71431	10.28568	37
25	4604	8876	5187	1,927	9,66319	9,94825	9,71493	10,28506	35
27	4609	8873	5194	1,925	9,66367	9,94812	9.71555	10,28444	33
29	4614	8871	5201	1,923	9,66416	9,94799	9,71616	10,28383	31
31	4620	8868	5209	1,919	9,66464	9,94786	9,71678	10.28321	29
33	4625	8866	5215	1,918	9.66513	9,94773	9,71740	10.28260	27
35	4630	8863	5222	1,914	9.66561	9,94760	9,71801	10.28198	25
37	4635	8860	5231	1,911	9.66610	9.94746	9,71863	10,28136	23
39	4640	8857	5238	1,908	9,66658	9,94733	9,71924	10,28075	21
41	4645	8855	5246	1,906	9,66706	9,94720	9,71986	10,28013	19
43	4650	8852	5253	1,903	9,66754	9,94707	9,72047	10,27952	17
45	4656	8849	5261	1,900	9,66802	9,94693	9,72109	10,27891	15
47	4661	8847	5268	1,898	9,66850	9,94680	9,72170	10.27829	13
49	4666	8844	5276	1,895	9.66898	9,94667	9,72231	10,27768	11
51	4671	8841	5283	1,892	9,66946	9,94653	9,72292	10 27707	9
53	4676	8839	5291	1,890	9,66994	9,94640	9,72353	10.27646	7
55	4681	8836	5298	1,887	9,67042	9,94627	9,72415	10,27585	5
57	4687	8833	5305	1,884	9,67089	9,94613	9.72475	10,27524	3
59	4692	8830	5313	1.882	9,67137	9.94600	9,72537	10.27463	1
		N.S.		N.T.		Log, si,		Log.tang	M

62 Degrees

28 Degrees,

M	N.si.		N,T,		Log. si.		Log.T.		
1	4697	8828	5320	1,879	9,67181	9,94586	9,72597	10,27402	59
3	4702	8825	5328	1,876	9,67232	9,94573	9,72658	10.27341	57
5	4707	8822	5336	1,874	9,67278	9,94559	9,72719	10,27280	55
7	4712	8819	5344	1,871	9,67326	9,94545	9,72780	10,27219	53
9	4717	8817	5350	1,869	9,67374	9,94532	9,72842	10,27158	51
11	4722	8814	5358	1,866	9,67397	9,94519	9,72902	10.27098	49
13	4728	8811	5365	1,863	9,67468	9,94505	9,72962	10,27037	47
15	4733	8808	5373	1,861	9,67515	9,94492	9,73023	10,26976	45
17	4735	8806	5380	1,858	9,67562	9,94478	9,73083	10,26916	43
19	4743	8803	5388	1,856	9,67609	9,94465	9,73144	10,26855	41
21	4748	8800	5395	1,853	9,67656	9,94451	9,73204	10.26795	39
23	4753	8797	5403	1,850	9,67703	9,94437	9,73265	10,26734	37
25	4758	8795	5410	1,848	9,67749	9,94424	9,73325	10.26674	35
27	4763	8792	5418	1,845	9,67796	9,94410	9,73386	10.26614	33
29	4769	8789	5425	1,843	9,67843	9,94396	9,73446	10.26553	31
31	4774	8786	5433	1,840	9,67889	9,94383	9,73506	10.26493	29
33	4779	8784	5440	1,838	9,67936	9,94369	9,73566	10,26433	27
35	4785	8781	5448	1,835	9,67982	9,94355	9,73626	10.26373	25
37	4789	8778	5455	1,832	9,68028	9,94341	9,73687	10.26313	23
39	4794	8775	5463	1,830	9,68075	9,94327	9,73747	10.26253	21
41	4799	8772	5471	1,827	9,68121	9,94314	9,73807	10.26193	19
43	4804	8770	5478	1,825	9,68167	9,94300	9,73867	10,26133	17
45	4809	8767	5486	1,822	9,68213	9,94286	9,73927	10.26073	15
47	4814	8764	5493	1,820	9,68259	9,94272	9,73987	10.26013	13
49	4820	8761	5501	1,817	9,68305	9,94258	9,74046	10,25953	11
51	4825	8758	5508	1,815	9,68351	9,94244	9,74106	10,25893	9
53	4830	8756	5516	1,813	9,68397	9,94230	9,74166	10,25833	7
55	4835	8753	5524	1,810	9,68443	9,94217	9,74226	10.25774	5
57	4840	8750	5531	1,808	9,68488	9,94202	9,74285	10,25714	3
59	4845	8747	5539	1,805	9,68534	9,94189	9,74345	10,25654	1
		N,si.		N,T		Log, si.		Log.tang,	M

61 Degrees

29 Degrees.

M	N, S.		N. T.		Log. S.		Log. T.		
1	4850	7[illegible]4	5540	1,802	9,68579	9.9[illegible]178	9,74[illegible]	10.25595	[illegible]
[illegible]	4853	8741	5554	1,800	9,68625	9.9[illegible]181	9,7[illegible]404	10.25535	[illegible]
5	4860	8730	5562	1,797	9,68671	9.9[illegible]184	9,74527	10.25476	55
7	4865	8726	5569	1,795	9,68[illegible]6	9.94[illegible]4	9,7459[illegible]	10.25416	53
9	4870	8733	5577	1,793	9,68761	9,94118	9,74651	10.25357	51
11	4876	8730	5584	1,790	9,68809	9,94104	9,74702	10.25297	49
13	4881	8727	5592	1,788	9,68852	9,94090	9,74756	10,25238	47
15	4886	8724	5600	1,786	9,68897	9,94076	9,74[illegible]	10,25179	45
17	4891	8722	5607	1,784	9,68[illegible]	9,94062	9,74858	10,25120	43
19	4896	8719	5615	1,782	9,6892[illegible]	9,9404[illegible]	9,74[illegible]	10,25060	41
21	4901	8716	5623	1,778	9,68983	9,94032	9,74998	10,25001	39
23	4906	8713	5630	1,776	9,69027	9,94018	9,75057	10,24942	37
25	4911	8710	5638	1,774	9,69122	9,94003	9,75117	10,24883	35
27	4916	8707	5646	1,771	9,69166	9,93989	9,75175	10,24822	33
29	4921	8704	5652	1,768	9,69211	9,93975	9,75234	10,24766	31
31	4926	8702	5661	1,766	9,69255	9,93961	9,75293	10,24706	29
33	4931	8699	5669	1,763	9,69300	9,93947	9,75352	10,24647	27
35	4936	8696	5676	1,761	9,69345	9,93933	9,75411	10.24588	25
37	4941	8693	5684	1,759	9,69389	9,93919	9,75470	10.24529	23
39	4947	8690	5692	1,756	9,69434	9,93905	9,75529	10,24471	21
41	4952	8687	5700	1,754	9,69478	9,93890	9,75587	10.24412	19
43	4957	8684	5707	1,752	9,69522	9,93876	9,7[illegible]6	10,24353	17
45	4962	8681	5715	1,749	9,6[illegible]567	9,93862	9,75705	10.24294	15
47	4967	8679	5723	1,747	9,6[illegible]61	9,93847	9,75763	10.24236	13
49	4972	8676	5731	1,745	9,69655	9,93833	9,7[illegible]82	10.24177	11
51	4977	8673	5738	1,742	9,69699	9,93819	9,75[illegible]88	10.24119	9
53	4982	8670	5746	1,740	9,6974[illegible]	9,93804	9,7593[illegible]	10.24060	7
55	4987	8667	5754	1,737	9,69787	9,93789	9,75994	10.24002	5
57	4992	8664	5761	1,735	9,69831	9,93774	9,76052	10,23943	3
59	4997	8660	5769	1,733	9,69876	9,93760	9,76111	10,23885	1
	C. S.	N. S.	C. T.	N. T.	co. sine	Log S.	co. tan.	Log. tang.	M

60 Degrees.

30 Degrees.

M	N, si,		N, T,		Log, S,		Log, T.		
1	5002	8658	5777	1,730	9,69919	9,93745	9,76173	10,23817	59
3	5007	8655	5785	1,728	9,69962	9,93731	9,76231	10,23768	57
5	5012	8652	5792	1,726	9,70006	9,93716	9,76289	10,23770	55
7	5017	8650	5800	1,723	9,70049	9,93702	9,76348	10.23652	53
9	5022	8647	5808	1,721	9,70093	9,93687	9,76406	10,23594	51
11	5027	8644	5812	1,719	9,70136	9,93672	9,76435	10.23535	49
13	5032	8641	5824	1,717	9,70180	9,93657	9,76522	10.23477	47
15	5037	8638	5831	1,714	9,70223	9,93643	9,76580	10.23419	45
17	5042	8635	5839	1,712	9,70267	9,93628	9,76668	10,23361	43
19	5047	8632	5847	1,710	9,70310	9,93613	9,76696	10,23303	41
21	5052	8629	5855	1,707	9,70353	9,93598	9,76754	10,23245	39
23	5057	8626	5863	1,705	9,70396	9,93584	9,76812	10,23187	37
25	5062	8623	5870	1,703	9,70439	9,93569	9,76870	10,23129	35
27	5067	8620	5878	1,701	9,70482	9,93554	9,76928	10,23073	33
29	5072	8617	5886	1,698	9,70525	9,93539	9,76986	10.23014	31
31	5077	8614	5894	1,696	9,70568	9,93524	9,77043	10,23956	29
33	5082	8611	5902	1,694	9,70611	9,93509	9,77101	10,22898	27
35	5087	8608	5910	1,692	9,70654	9,93444	9,77059	10.22840	25
37	5092	8605	5917	1,689	9,60696	9,93479	9,77216	10,22783	23
39	5097	8602	5925	1,687	9,70739	9,93465	9,77274	10.22725	21
41	5102	8600	5933	1,685	9,70784	9,93449	9.77332	10,22668	19
43	5107	8597	5941	1,683	9,70824	9,93435	9.77389	10,22610	17
45	5112	8594	5949	1,680	9,70867	9,93420	9,77447	10,22553	15
47	5117	8591	5957	1,678	9,70909	,993404	9.77504	10,22495	13
49	5122	8588	5965	1,676	9,70951	9,93389	9,77562	10.22438	11
51	5127	8585	5973	1,674	9.70994	9,93374	9,77619	10,22380	9
53	5132	8582	5980	1,672	9,71036	9,93359	9,77676	10,22323.	7
55	5137	8579	5988	1,669	9,71078	9,93344	9.77734	10,22265	5
57	5142	8576	5996	1,668	9,71120	9.93329	9 77791	10,22208	3
59	5147	8573	6004	1,665	9,71163	9.93314	9,77848	10,22151	1
		N, si.		N, T,		Log. si.		Log, tang,	M

59 Degrees

31 Degrees

M	N,n,		N,T,		Log ſi,		Log. T,		
1	5147	8570	6012	1.663	9.71204	9,9329	9,77906	10,22094	59
3	5157	8567	6020	1,661	9,712:6	9,9328	9.77963	10,22036	57
5	5162	8564	6028	1.658	9.71288	9,93268	9,78020	10.21978	55
7	5167	8561	6036	1,650	9,71330	9,93253	9,78077	10.21922	53
9	5172	8558	6044	1,654	9,71372	9,93238	9,78134	10,21865	51
11	5177	555	6052	1.652	9,71414	9,93222	9,78191	10,21808	49
13	5182	8552	6060	1.650	9,71456	9,93207	9,78248	10,21751	47
15	5187	8549	6068	1,648	9,71497	9.93192	9,7830,	10.21694	45
17	5192	8546	6076	1,645	9.71539	9.93176	9.78362	10,21637	43
19	5197	8543	6084	1,643	9,71580	9,93161	9.78419	10,21580	41
21	5202	8540	6092	1,641	9.71622	9,93146	9,78476	10.21523	39
23	5207	8537	6100	1,639	9.71664	9,93130	9,78533	10.21466	37
25	5212	8533	6108	1,637	9.71705	9,93115	9,78590	10,21410	35
27	5217	8531	6116	1,635	9,71746	9,93099	9,78646	10,21353	33
29	5222	8528	6124	1,633	9,71787	9,93084	9.78703	0,21396	31
31	5227	8524	6132	1,630	9,71829	9,93068	9,78760	10,21239	29
33	5232	8521	6140	1,628	9,71870	9,93053	9,78817	0.21183	27
35	5237	8518	6148	1,626	9,71911	9,93037	9.78873	10,21126	25
37	5242	8515	6156	1.624	9,71952	9,93022	9.78930	10.21069	23
39	5247	8511	6164	1,622	9,71093	9,93006	9,78986	10,21013	21
41	5252	8509	6172	1,620	9,72034	9,92991	9,79043	10.20956	19
43	5257	8500	6180	1,618	9,72075	9,92975	9,79100	10,20900	17
45	5262	8505	6188	1,616	9,72116	9,92959	9.79156	10,20843	15
47	5267	8500	6196	1.613	9,72157	9.92944	9,79212	10.20787	13
49	5272	8497	6204	1,611	9.72197	9.92928	9,79269	10,20730	11
51	5276	8494	6212	1,609	9.72238	9,92913	9.79325	10.20674	9
53	5281	8491	6220	1,607	9.72279	9.92897	9,7938.	10,20618	7
55	5286	8488	6228	1.605	9,72319	9,92881	9,79438	10.20561	5
57	5291	8485	6236	1,603	9,72360	9.92865	9,79494	10,20505	3
59	5296	8482	6244	1,601	9,72400	9,92849	9,79550	10,20449	1
		N.S.		N,T,		Log, ſi,		Log,tang.	M

58 Degrees

The Explanation and Uſe of the Table.

1ſt. When the degrees which you want the ſines and tangents of, is at the top of the table, the minutes are on the left hand ſide of the page, beginning at the top and continuing downwards, as 1, 3, 5, 7, 9, &c. to 60 minutes.

32 Degrees.

M	N. fi.		N. T.		Log. S.		Log. T.		
1	5301	8478	6252	1,599	9,72441	9,92834	9,79607	10,20393	59
3	5306	8475	6260	1,597	9,72481	9,92818	9,79663	10,20336	57
5	5311	8472	6268	1,595	9,72521	9,92802	9,79719	10,20384	55
7	5316	8469	6277	1,593	9,72562	9,92780	9,79775	10,20224	53
9	5321	8466	6285	1,591	9,72602	9,92770	9,79831	10,20168	51
11	5326	8463	6293	1,589	9,72642	9,92754	9,79887	10,20112	49
13	5331	8460	6301	1,587	9,72682	9,92739	9,79943	10,20058	47
15	5336	8457	6309	1,585	9,72723	9,92723	9,79999	10,20000	45
17	5341	8454	6317	1,582	9,72762	9,92707	9,80055	10,19944	43
19	5345	8451	6325	1,580	9,72802	9,92691	9,80111	10,19888	41
21	5350	8447	6333	1,578	9,72842	9,92675	9,80167	10,19832	39
23	5355	8444	6342	1,576	9,72882	9,92654	9,80223	10,19776	37
25	5360	8441	6350	1,574	9,72922	9,92643	9,80279	10,19720	35
27	5365	8438	6358	1,572	9,72962	9,92627	9,80335	10,19664	33
29	5370	8435	6366	1,570	9,73001	9,92611	9,80390	10,19609	31
31	5375	8432	6374	1,568	9,73041	9,92594	9,80446	10,19553	29
33	5380	8429	6382	1,566	9,73081	9,92578	9,80502	10,19497	27
35	5385	8426	6391	1,564	9,73120	9,92562	9,80558	10,19442	25
37	5390	8432	6399	1,562	9,73160	9,92546	9,80613	10,19386	23
39	5395	8415	6407	1,560	9,73199	9,92530	9,80669	10,19330	21
41	5399	8410	6415	1,558	9,73239	9,92514	9,80724	10,19275	19
43	5404	8413	6423	1,556	9,73278	9,92497	9,80780	10,19219	17
45	5409	8410	6432	1,554	9,73317	9 92481	9,80836	10,19163	15
47	5414	8407	6440	1,552	9,73356	9,92466	9,80891	10,19108	13
49	5419	8404	6448	1,550	9,73396	9,92447	9,80947	10,19052	11
51	5424	8400	6456	1,549	9,73435	9,92432	9,81002	10,18997	9
53	5429	8397	6465	1,546	9,73474	9,92416	9,81058	10,18942	7
55	5434	8394	6473	1,544	9,73513	9,92400	9,81113	10,18886	5
57	5439	8391	6481	1,543	9,73552	9,92383	9 81168	10,18831	3
59	5443	8388	6489	1,541	9,73591	9,92367	9,81224	10,18775	1
		N. fi		N, T.		Log. fi.		Log. tang.	M

57 Degrees

2d. When the degrees are at the bottom of the page, the minutes are at the right hand side of the page, beginning at the bottom and counting upwards, with 1, 3, 5, 7, 9, &c. to 60.

And Radius of the table of natural sines and tangents, &c. being 1, the sines, tangents, &c. must be considered as decimal numbers, and all natural tangents above 45 degrees, will exceed Radius, that is, they will be mixt numbers.

33 Degrees.

M	N. S.		N. T.		Log. S.		Log. T.		
1	5448	8385	6498	1,533	9,73630	9,92350	9,81279	10,18721	59
3	5453	8381	6506	1,536	9,73669	9,92334	9,81334	10,18665	57
5	5458	8378	6514	1,534	9,73708	9,92318	9,81390	10,18619	55
7	5463	8375	6523	1,533	9,73746	9,92301	9,81445	10,18554	53
9	5468	8372	6531	1,531	9,73785	9,92285	9,81500	10,18499	51
11	5473	8369	6539	1,529	9,73824	9,92268	9,81555	10,18445	49
13	5478	8366	6547	1,527	9,73862	9,92252	9,81610	10,18389	47
15	5482	8363	6556	1,525	9,73901	9,92235	9,81665	10,18334	45
17	5487	8359	6564	1,523	9,73939	9,92218	9,81721	10,18279	43
19	5492	8356	6572	1,521	9,73978	9,92202	9,81775	10,18224	41
21	5497	8353	6581	1,519	9,74016	9,92185	9,81881	10,18169	39
23	5502	8350	6589	1,517	9,74055	9,92169	9,81886	10,18114	37
25	5507	8346	6597	1,515	9,74093	9,92152	9,81941	10,18059	35
27	5512	8343	6606	1,513	9,74131	9,92135	9,81995	10,18004	33
29	5516	8340	6614	1,511	9,74169	9,92119	9,82050	10,17949	31
31	5521	8337	6623	1,509	9,74208	9,92103	9,82105	10,17894	29
33	5526	8334	6631	1,507	9,74246	9,92085	9,82138	10,17839	27
35	5531	8330	6639	1,506	9,74284	9,92068	9,82215	10,17784	25
37	5536	8327	6648	1,504	9,74322	9,92052	9,82270	10,17729	23
39	5541	8324	6656	1,502	9,74360	9,92035	9,82325	10,17675	21
41	5545	8321	6664	1,500	9,74398	9,92018	9,82379	10,17620	19
43	5550	8317	6673	1,498	9,74436	9,92001	9,82434	10,17565	17
45	5555	8314	6681	1,496	9,7447	9,91984	9,82489	10,17510	15
47	5560	8311	6690	1,494	9,74511	9,91967	9,82543	10,17456	13
49	5565	8303	6698	1,492	9,74549	9,91950	9,82598	10,17450	11
51	5570	8304	6707	1,490	9,74557	9,91933	9,82653	10,17346	9
53	5575	8301	6715	1,489	9,74624	9,91916	9,82707	10,17292	7
55	5579	8298	6723	1,487	9,74662	9,91900	9,82762	10,17237	5
57	5584	8295	6732	1,485	9,74699	9,91883	9,82817	10,17183	3
59	5589	8292	6740	1,483	9,74737	9,91860	9,82871	10,17128	1
		N.S.		N. T.		Log. S.		Log. tang.	M

56 Degrees.

The four first columns contains the Natural sines and Tangents, the four last contains the Artificial Sines and Tangents.

When you want to find the natural sine, tangent logarithmic, or artificial sine or tangent for any number of degrees and minutes under 45 deg. Look for the degrees at the top of the table, minutes on the left and side; against which, and under N. S. at the top, you have the

34 Degrees,

M.	N. fi.		N. T.		Log. fi.		Log. T.		
1	5594	8288	6749	1,481	9,74774	9,91848	9,82926	10,17074	59
3	5599	8285	6757	1,479	9,74812	9,91831	9,82980	10,17019	57
5	5603	8282	6766	1,478	9,74849	9,91814	9,83035	10,16965	55
7	5608	8278	6774	1,476	9,74887	9,91797	9,83089	10,16915	53
9	5613	8275	6783	1,474	9,74929	9,91780	9,83143	10,16856	51
11	5618	8272	6791	1,472	9,74961	9,91763	9,83198	10,16801	49
13	5623	8269	6800	1,470	9,74998	9,91746	9,83252	10,16747	47
15	5628	8265	6808	1,468	9,75035	9,91729	9,83306	10,16693	45
17	5632	8262	6817	1,466	9,75072	9,91711	9,83361	10,16638	43
19	5637	8259	6825	1,465	9,75100	9,91694	9,83415	10,16584	41
21	5642	8256	6834	1,463	9,75140	9,91677	9,83469	10,16530	39
23	5647	8252	6842	1,461	9,75183	9,91660	9,83523	10,16476	37
25	5652	8249	6851	1,459	9,75220	9,91642	9,83578	10,16422	35
27	5656	8246	6859	1,457	9,75257	9,91625	9,83632	10,16367	33
29	5661	8242	6868	1,455	9,75294	9,91608	9,83686	10,16313	31
31	5666	8239	6877	1,454	9,75331	9,91590	9,83740	10,16259	29
33	5671	8236	6885	1,452	9,75367	9,91573	9,83794	10,16205	27
35	5676	8232	6894	1,450	9,75404	9,91555	9,83848	10,16151	25
37	5680	8229	6902	1,448	9,75441	9,91539	9,83902	10,16097	23
39	5685	8226	6911	1,446	9,75477	9,91521	9,83956	10,16043	21
41	5690	8222	6920	1,445	9,75514	9,91503	9,84010	10,15989	19
43	5693	8219	6928	1,443	9,75550	9,91486	9,84064	10,15935	17
45	5699	8216	6937	1,441	9,75587	9,91468	9,84118	10,15881	15
47	5704	8212	6945	1,439	9,75623	9,91451	9,84172	10,15827	13
49	5709	8209	6954	1,437	9,75660	9,91433	9,84226	10,15773	11
51	5714	8206	6963	1,436	9,75696	9,91415	9,84280	10,15719	9
53	5719	8202	6971	1,434	9,75732	9,91398	9,84334	10,15665	7
55	5723	8199	6980	1,432	9,75768	9,91380	9,84388	10,15611	5
57	5728	8196	6989	1,430	9,75804	9,91363	9,84442	10,15558	3
59	5733	8192	6997	1,429	9,75841	9,91343	9,84495	10,15504	1
		N, fi.		N, T.		Log, fi.		Log. tang,	M

55 Degrees

the natural fine required. Alſo, under N. T. you have the natural tangent, under Log. S. you have log. fine, and under Log. tan. you will have the log. tangent, of the degrees and minutes required.

Example 1ſt. I deſire to find the Natural Sine, Natural Tangent, Log. Sine, and Log. Tangent, of 19 deg. 15 min.

Look

35 Degrees

M.	N, ſi,		N, T,		Log ſi,		Log. T,		
1	5738	8189	7000	1.427	9 75877	9,91327	9,84549	10,15450	59
3	5742	8186	7015	1,425	9,75913	9,91309	9,84603	10.15396	57
5	5747	8183	7023	1.423	9.75949	9,91292	9.84657	10,15342	55
7	5752	8179	7032	1,422	9,75985	9,91274	9.84710	10,15289	53
9	5757	8176	7041	1,420	9,76021	9,91256	9,84764	10.15235	51
11	5761	8173	7049	1,418	9,76056	9,91238	9,84818	10,15181	49
13	5766	8169	7058	1.416	9,76092	9,91221	9,84871	10,15128	47
15	5771	8166	7067	1.414	9,76128	9.91203	9,84925	10,15074	45
17	5776	8163	7076	1,413	9.76164	9.91185	9,84979	0,15021	43
19	5780	8159	7084	1.411	9,76199	9,91167	9.8503-	.0.14967	41
21	5785	8156	7093	1,409	9.76235	9,91149	9,85086	10.14913	39
23	5,90	8152	7102	1,407	9.76271	9,91131	9,85139	10,14860	37
25	5795	8149	7111	1.406	9.76306	9,91113	9.85193	10.14806	35
27	5799	8140	7119	1,404	9,76342	9,91095	9.85246	10,14753	33
29	5804	8142	7128	1,403	9,76377	9,91077	9,85300	10,14699	31
31	5809	8139	7137	1,401	9,76413	9,91059	9,85353	10,14646	29
33	5814	8136	7140	1,399	9,76448	9,91041	9,85406	10,14593	27
35	5818	8133	7154	1,397	9.76483	9,91023	9,85460	10,14539	25
37	5823	8129	7163	1,395	9,76519	9,91005	9,85513	10.14486	23
39	5828	8125	7172	1,394	9,76554	9,90987	9.85567	10.14432	21
41	5833	8122	7181	1,392	9.76589	9,90969	9,85620	10,14379	19
43	5837	8119	7190	1.390	9,76624	9,90951	9,85673	10.14326	17
45	5842	8115	7198	1,389	9,76659	9,90932	9.85727	10,14273	15
47	5847	8112	7207	1.387	9.76694	9.90914	9.85780	10,14219	13
49	5851	8109	7216	1.385	9,76729	9,90896	9,85833	10,14166	11
51	5856	8105	7225	1,383	9.76764	9,90878	9,85886	10.14113	9
53	5801	8102	7234	1,382	9.76799	9.90859	9,85940	10,14060	7
55	5866	8098	7243	1,380	9,76834	9,90841	9,85993	10.14006	5
57	5870	8095	7252	1,378	9,76869	9.90823	9,86046	10.13953	3
59	5875	8091	7260	1,377	9,76904	9,90804	9,86099	10,13900	1
		N.S.		N, T,		Log, ſi,		L g, tang.	M

54 Degrees

Look for 12 degrees at the top of the page, and 19 min. in the firſt column on the left hand ſide, againſt which, and under Nat. Sine at the top, you will, have 2121, its Nat. Sine, and againſt 15 min. and under Nat. Tan. you will have 2171 the Nat. Tan. required; and under Log. Sine and againſt 15 min. ſtands 9,32676, the Log. Sine. and under Log. Tan. you find 9.33670 the Log. Tan. as was required.

36 Degrees.

M.	N. s.		N. T.		Log. s.		L. T.		
1	5880	8088	7265	1,375	9,76917	9,90786	9,86132	10,13847	59
3	5884	8085	7273	1,373	9,76973	9,90768	9,86205	10,13794	57
5	5889	8081	7287	1,372	9,77008	9,90749	9,86258	10,13741	55
7	5894	8078	7296	1,370	9,77043	9,90731	9,86311	10,13688	53
9	5899	8074	7305	1,368	9,77077	9,90712	9,86365	10,13638	51
11	5903	8071	7314	1,367	9,77112	9,90694	9,86418	10,13581	49
13	5908	8067	7323	1,365	9,77147	9,90675	9,86471	10,13528	47
15	5913	8064	7332	1,363	9,77181	9,90657	9,86525	10,13475	45
17	5917	8061	7341	1,362	9,77215	9,90638	9,86577	10,13422	43
19	5922	8057	7350	1,360	9,77250	9,90620	9,86629	10,13370	41
21	5927	8054	7359	1,358	9,77284	9,90601	9,86682	10,13317	39
23	5931	8050	7368	1,357	9,77319	9,90583	9,86735	10,13264	37
25	5936	8047	7377	1,355	9,77353	9,90564	9,86788	10,13211	35
27	5941	8043	7386	1,353	9,77387	9,90545	9,86841	10,13158	33
29	5945	8041	7395	1,352	9,77421	9,90527	9,86894	10,13105	31
31	5950	8036	7404	1,350	9,77455	9,90508	9,86947	10,13052	29
33	5955	8033	7413	1,348	9,77489	9,90489	9,87000	10,12999	27
35	5959	8029	7422	1,347	9,77523	9,90471	9,87052	10,12947	25
37	5964	8026	7431	1,345	9,77555	9,90452	9,87105	10,12894	23
39	5969	8022	7440	1,343	9,77591	9,90433	9,87158	10,12841	21
41	5973	8019	7449	1,342	9,77625	9,90414	9,87211	10,12788	19
43	5978	8015	7458	1,340	9,77659	9,90395	9,87263	10,12736	17
45	5983	8012	7467	1,339	9,77693	9,90377	9,87316	10,12683	15
47	5987	8009	7476	1,337	9,77727	9,90358	9,87369	10,12630	13
49	5992	8005	7485	1,335	9,77761	9,90339	9,87422	10,12577	11
51	5997	8002	7494	1,334	9,77795	9,90320	9,87474	10,12525	9
53	6001	7998	7503	1,332	9,77828	9,90301	9,87527	10,12472	7
55	6006	7995	7512	1,331	9,77862	9,90282	9,87579	10,12420	5
57	6011	7991	7521	1,329	9,77895	9,90263	9,87632	10,12367	3
59	6015	7988	7530	1,327	9,77929	9,90244	9,87685	10,12314	1
		N. s.		N. T.		Log. s.		Log. T.	M.

53 Degrees

Example 2d. Required the Natural Sine, Natural Tangent, Log. Tangent of 77 ,39.

Find 77 Degrees at bottom of the table, and 39 min. on the laſt column on the right hand ſide of the page, and againſt it, and above Natural Sine at the bottom, ſtands 9761, which is the N. S. of 77 ,39, and above Natural Tangent at bottom ſtands 4,567 the N. T. required,

and

37 Degrees.

M	N, fi.		N.T.		L. g. S		Log. T.		
1	6020	984	7540	1,326	9,77903	9,90245	9,87737	10,12202	59
3	6025	7981	7545	1,324	9,77990	9,90200	9,87790	10,12240	57
5	602	7977	7550	1,323	9,78030	9,90167	9,87842	10,12157	55
7	6034	7974	7557	1,321	9,78000	9,90168	9,87793	10,12204	53
9	6038	970	7561	1,319	9,78090	9,90140	9,87741	10,12052	51
11	6041	7967	7568	1,318	9,78130	9,90115	9,87690	10,11999	49
13	6048	7963	7574	1,316	9,78170	9,90110	9,87632	10,11947	47
15	6052	7960	7004	1,315	9,78210	9,90091	9,87581	10,11894	45
17	6056	7956	7013	1,313	9,78249	9,90074	9,87531	10,11842	43
19	6062	7952	7022	1,311	9,78289	9,90054	9,87481	10,11789	41
21	6066	7949	7031	1,310	9,78328	9,90033	9,87430	10,11737	39
23	6071	7945	7040	1,308	9,78367	9,90014	9,87380	10,11685	37
25	6075	7942	7050	1,307	9,78406	9,89993	9,87330	10,11634	35
27	6080	7938	7059	1,305	9,78445	9,89975	9,87280	10,11582	33
29	6084	7935	7068	1,304	9,78484	9,89953	9,87230	10,11528	31
31	6089	7931	7077	1,302	9,78523	9,89930	9,87180	10,11475	29
33	6093	7928	7087	1,300	9,78562	9,89911	9,87130	10,11423	27
35	6098	7924	7096	1,299	9,78601	9,89890	9,87080	10,11371	25
37	6102	7921	7105	1,297	9,78639	9,89870	9,87031	10,11318	23
39	6108	7917	7114	1,296	9,78678	9,89850	9,86981	10,11266	21
41	6112	7914	7124	1,294	9,78716	9,89829	9,86931	10,11214	19
43	6117	7910	7133	1,293	9,78755	9,89820	9,86881	10,11162	17
45	6122	7906	7142	1,291	9,78793	9,89800	9,86831	10,11110	15
47	6126	7903	7152	1,290	9,78832	9,89781	9,86782	10,11057	13
49	6131	7899	7161	1,288	9,78870	9,89761	9,86732	10,11005	11
51	6135	7896	7170	1,287	9,78909	9,89741	9,86683	10,10953	9
53	6140	7892	7180	1,285	9,78948	9,89722	9,86634	10,10901	7
55	6145	7889	7189	1,283	9,78986	9,89702	9,86585	10,10849	5
57	6150	7885	7198	1,282	9,79025	9,89682	9,86536	10,10797	3
59	6155	7881	7208	1,280	9,79063	9,89663	9,86487	10,10745	1
		N.S		N. T.		Log. S.		Log. tang	M

52 Degrees.

above 77 and against 39. above Log. fine at the bottom, ſtands 9,98983 the Log. fine required; and above 77 degrees, and againſt 3. min. above Log. Tangent at bottom, ſtands 10,05965 the Log. Tangent of 77 ,39 as was required.

Caſe 2d. When the minute you ſeek for is not in the table, you muſt find the Nat. line, Nat. tangent, Log. fine and Log. tangent of the

the

38 Degrees.

M	N, fi,		N.T.		Log, S,		Log, T.		
1	6159	7878	7817	1,279	9,78950	9,89043	9,89307	10,10693	59
3	6163	7874	7826	1,277	9,78982	9,89623	9,89359	10.10641	57
5	6168	7871	7836	1,276	9,79014	9,89603	9,89411	10,10588	55
7	6172	7867	7845	1,274	9,79047	9,89584	9,89463	10.10536	53
9	6177	7863	7855	1,273	9,79079	9,89564	9,89515	10,10484	51
11	6181	7860	7864	1,271	9,79111	9,89544	9,89567	10,10432	49
13	6186	7856	7873	1,270	9,79143	9,89524	9,89619	10.10380	47
15	6190	7853	7883	1,268	9,79175	9,89504	9,89617	10,10328	45
17	6195	7849	7892	1,266	9,79207	9,89484	9,89723	10,10276	43
19	6200	7845	7902	1,265	9,79239	9,89464	9,89775	10,10224	41
21	6204	7842	7911	1,263	9,79271	9,89444	9,89827	10,10173	39
23	6209	7838	7921	1,262	9,79303	9,89424	9,89879	10,10121	37
25	6213	7835	7930	1,260	9,79335	9,89404	9,89930	10,10069	35
27	6218	7831	7940	1,259	9,79367	9,89384	9,89982	10,10017	33
29	6222	7827	7949	1,257	9,79399	9,89364	9,90034	10,09965	31
31	6227	7824	7959	1,256	9,79430	9,89344	9,90086	10,09913	29
33	6231	7820	7968	1,254	9,79462	9,89324	9,90138	10,09861	27
35	6236	7817	7978	1,253	9,79494	9,89304	9,90190	10.09807	25
37	6241	7813	7987	1,251	9,79525	9,89283	9,90241	10,09758	23
39	6245	7809	7997	1,250	9,79557	9,89263	9,90293	10.09706	21
41	6250	7806	8006	1,248	9,79589	9,89243	9,90345	10.09654	19
43	6254	7802	8016	1,247	9,79620	9,89223	9,90397	10.09602	17
45	6259	7798	8025	1,245	9,79652	9,89203	9,90449	10,09550	15
47	6263	7795	8035	1,244	9,79683	9,89183	9,90500	10,09499	13
49	6268	7791	8044	1,243	9,79715	9,89162	9,90552	10.09447	11
51	6272	7787	8054	1,241	9,79746	9,89142	9,90604	10,09395	9
53	6277	7784	8064	1,240	9,79777	9,89121	9,90656	10,09344	7
55	6281	7780	8073	1,238	9,79809	9,89101	9,90707	10,09292	5
57	6286	7776	8083	1,237	9,79840	9,89080	9 90759	10,09240	3
59	6290	7773	8093	1,235	9,79871	9,89060	9,90811	10,09188	1
		N. fi.		N,T.		Log. fi.		Log,tang,	M

51 Degrees

next minute, above the minute you seek for, and also, for the next below it, and add these two fines together, and half the sum is Natural fine, Nat: Tangent, Log. fine, or Log. tangent, which ever you seek for.

Example 3d. Required the Natural fine, and Natural Tangent, Log, fine, and Log tangent of 12 ,18.

Find

39 Degrees

M	N,fi,		N,T,		Log. fi,		Log. T,		
1	6295	7769	8102	1,234	9.79902	9,89040	9,90862	10,09137	59
3	6299	7765	8112	1,232	9,79933	9,89019	9,90914	10.09085	57
5	6304	7762	8121	1,231	9.79965	9,88999	9.90966	10,09034	55
7	6309	7758	8131	1,229	9,79996	9,88978	9.91017	10,08982	53
9	6313	7754	8141	1,228	9,80027	9,88957	9,91069	10.08930	51
11	6318	7751	8150	1,226	9,80058	9,88937	9,91120	10,08879	49
13	6322	7747	8160	1.225	9,80089	9,88916	9,91172	10,08827	47
15	6327	7743	8170	1.224	9,80120	9.88896	9,91224	10,08776	45
17	6331	7740	8180	1,223	9.80151	9.88875	9,91275	10,08724	43
19	6336	7736	8189	1.221	9.80181	9,88854	9.91327	10.08672	41
21	6340	7732	8199	1,219	9.80212	9,88834	9,91378	10.08621	39
23	6345	7729	8209	1,218	9.80243	9,88813	9,91430	10,08569	37
25	6349	7725	8218	1.216	9.80274	9,88792	9.91481	10.08518	35
27	6354	7721	8228	1,215	9,80306	9,88771	9.91533	10,08466	33
29	6358	7718	8238	1,213	9,80335	9,88751	9,91584	10,08415	31
31	6363	7714	8248	1,212	9,80366	9,88730	9,91636	10.08363	29
33	6367	7710	8258	1,211	9,80397	9,88709	9,91687	10,08312	27
35	6371	7706	8267	1,209	9,80427	9,88689	9,91739	10,08260	25
37	6376	7703	8277	1,208	9,80458	9,88667	9,91790	10.08209	23
39	6380	7699	8287	1,206	9,80488	9,88646	9.91842	10.08158	21
41	6385	7695	8297	1,205	9,80519	9,88625	9,91893	10,08106	19
43	6389	7692	8307	1.203	9,80549	9,88604	9,91944	10.08055	17
45	6394	7688	8316	1,202	9,80579	9,88583	9,91996	10,08003	15
47	6398	7684	8326	1,201	9.80610	9.88562	9,92047	10,07952	13
49	6403	7680	8336	1.199	9,80640	9.88541	9.92099	10,07901	11
51	6407	7677	8346	1,198	9.80670	9,88520	9.92150	10.07849	9
53	6412	7673	8356	1,196	9.80701	9.88499	9,92201	10,07798	7
55	6416	7669	8366	1,195	9,80731	9,88478	9,92253	10.07747	5
57	6421	7666	8376	1,193	9,80761	9.88457	9,92304	10.07695	3
59	6425	7662	8386	1,192	9,80791	9,88436	9,92355	10,07644	1
		N.S.		N,T,		Log, fi,		Log,tang.	M

50 Degrees

Find the Natural fine and Tangent, and Log. fine and Tangent, next above and below the required degree and minute, as in the next page.

40 Degrees.

M	N, fi.		N.T.		Log. S.		Log. T,		
1	6430	7658	8395	1,191	9,80821	9,88414	9.92407	10,07593	59
3	6434	7654	8405	1,189	9,80851	9,88393	9.92458	10.07541	57
5	6439	7651	8415	1,188	9,80881	9,88372	9,92509	10.07490	55
7	6443	7647	8425	1,186	9,80911	9,88351	9.92567	10,07439	53
9	6447	7643	8435	1,185	9,80941	9,88329	9,92612	10.07387	51
11	6452	7639	8445	1,184	9,80971	9.88308	9,9266	10,07336	49
13	6456	7636	8455	1,182	9,81001	9.88287	9,92714	10.07285	47
15	6461	7632	8465	1,181	9,81031	9,88265	9,92765	10,07234	45
17	6465	7628	8475	1,179	9,81061	9,88244	9,92817	10,07182	43
19	6470	7624	8485	1,178	9,81091	9,88222	9,92868	10,07131	41
21	6474	7621	8495	1,177	9,81121	9,88201	9,92919	10,07080	39
23	6478	7617	8505	1,175	9,81150	9,88179	9,92970	10,07029	37
25	6483	7613	8515	1,174	9,81180	9,88158	9,93021	10,06978	35
27	6487	7609	8525	1,172	9,81210	9,88136	9.93073	10,06926	33
29	6492	7605	8535	1,171	9,81239	9,88115	9,93124	10,06875	31
31	6496	7602	8545	1,170	9,81269	9,88093	9,93175	10,06824	29
33	6501	7598	8555	1,168	9,81298	9,88072	9,93226	11,06773	27
35	6505	7594	8565	1,167	9,81328	9,88050	9,93277	10,06722	25
37	6509	7590	8576	1,166	9,81357	9,88028	9,93328	10,06671	23
39	6514	7587	8586	1,164	9,81387	9,88007	9,93380	10.06620	21
41	6518	7583	8596	1,162	9,81416	9,87985	9,93431	10.06568	19
43	6523	7579	8606	1,161	9,81446	9,87963	9,93482	10.06517	17
45	6527	7575	8616	1,160	9,81475	9,87942	9,93533	10,06466	15
47	6532	7571	8626	1,159	9,81504	9,87920	9.93584	10,06415	13
49	6536	7568	8636	1,157	9,81533	9,87898	9,93635	10.06364	11
51	6540	7564	8647	1,156	9,81563	9,87876	9,93686	10.06313	9
53	6545	7560	8657	1,155	9,81592	9,87854	9,93737	10,06262	7
55	6549	7556	8667	1,153	9,81621	9,87832	9,93788	10.06211	5
57	6554	7552	8677	1,152	9,81650	9,87810	9,93839	10.06160	3
59	6558	7549	8687	1,151	9,81679	9,87789	9,93890	10.06109	1
		N.S.		N. T.		Log. S.		Log.tang.	M

49 Degrees.

N. S.	N.T.	Log. S.	Log. tan.
12,17 is 2127	2117	9,32786	9,33792
12,19 is 2133	2183	9,32902	9,33913
4260	4300	18,65688	18,67795

N. S. 2130 N.T. 2150 Log. S. 9,32844 Log.T. 9,33897

Hence

41 Degrees.

M	N, fi,		N.T.		Log ,S,		Log, T.		
1	6562	7545	8697	1,149	9,81708	9,87707	9,93941	10,06058	59
3	6567	7541	8708	1,148	9,81737	9,87745	9,93992	10.06007	57
5	6571	7537	8718	1,146	9,81766	9,87723	9,94043	10,05956	55
7	6575	7533	8728	1,145	9,81795	9,87701	9,94094	10.05905	53
9	6580	7529	8738	1,144	9.81824	9,87678	9,94145	10,05854	51
11	6584	7526	8749	1,142	9,81853	9,87656	9,94196	10,05803	49
13	6589	7522	8759	1,141	9,81882	9,87634	9,94247	10.05752	47
15	6593	7518	8769	1,140	9,81911	9,87612	9,94298	10,05701	45
17	6597	7514	8780	1,138	9,81940	9,87590	9.94349	10,05650	43
19	6602	7510	8790	1,137	9,81968	9,87568	9,94400	10,05599	41
21	6606	7506	8800	1,136	9,81997	9,87545	9,94451	10,05548	39
23	6610	7503	8811	1,135	9,82026	9,87523	9,94502	10,05497	37
25	6615	7499	8821	1,133	9,82055	9,87501	9,94553	10,05446	35
27	6619	7495	8831	1,132	9,82083	9,87479	9,94604	10,05395	33
29	6624	7491	8842	1,130	9,82112	9,87456	9,94655	10,05344	31
31	6628	7487	8852	1,129	9,82140	9,87434	9,94706	10,05293	29
33	6632	7483	8862	1,128	9,82169	9,87412	9,94757	10,05242	27
35	6637	7479	8873	1,126	9,82197	9,87389	9,94808	10.05191	25
37	6641	7476	8883	1,125	9,82226	9,87367	9,94859	10,05141	23
39	6645	7472	8894	1,124	9,82254	9 87344	9,94909	10.05090	21
41	6650	7468	8904	1,123	9,82283	9,87322	9.94960	10.05039	19
43	6654	7464	8914	1,121	9,82311	9,87299	9.95011	10.04988	17
45	6658	7460	8925	1,120	9,82339	9.87277	9,95062	10,04937	15
47	6663	7456	8935	1,119	9,82368	9.87254	9,95113	10,04886	13
49	6667	7452	8946	1,117	9,82396	9,87232	9,95164	10.04835	11
51	6671	7448	8956	1,116	9,82424	9,87209	9,95215	10,04785	9
53	6676	7445	8967	1,115	9.82452	9,87186	9,95265	10,04734	7
55	6680	7441	8977	1,113	9,82480	9,87164	9.95316	10,04683	5
57	6684	7437	8988	1,112	9.82509	9,87118	9,95367	10,04632	3
59	6689	7433	8998	1,111	9,82537	9,87107	9,95418	10,04581	1
		N, fi.		N,T,		Log. fi.		Log,tang,	M

48 Degrees

Hence the Natural Sine of 12 ,18 is 2130, its Natural Tangent equal 2150, its Log. S. is 9,32897, Log. Tangent 9,33897, as was required.

Example 4th. Required the Natural Sine, natural Tangent, Log. fine, and Log. tangent of 21 ,00.

Find the natural fine and tangent, and Log. fine and tangent, above and below and take half their ſum as in the laſt example.

N. S.

42 Degrees,

M	N.fi.		N,T,		Log fi.		Log. T.		
1	6693	7429	9009	1,109	9,82565	9,87096	9,95469	10.04430	59
3	6697	7425	9019	1,108	9,82593	9,87073	9,95519	10,04480	57
5	6702	7421	9030	1,107	9,82621	9.87050	9,95570	10.04429	55
7	6706	7417	9040	1,106	9,82649	9,87027	9,95621	10,04378	53
9	6710	7413	9051	1,104	9,82677	9,87004	9.95672	10,04327	51
11	6715	7410	9062	1,103	9,82704	9,86981	9,95723	10,04276	49
13	6719	7406	9072	1,102	9.82732	9,86958	9,95773	10,04226	47
15	6723	7402	9083	1,100	9,82760	9,86936	9,95824	10,04175	45
17	6727	7398	9093	1,099	9,82788	9,86913	9,95875	10,04124	43
19	6732	7394	9104	1,098	9,82816	9,86891	9,95926	10,04073	41
21	6736	7390	9115	1,097	9,82843	9,86867	9,95976	10.04023	39
23	6740	7386	9125	1,095	9.82871	9,86844	9,96027	10,03972	37
25	6745	7382	9136	1,094	9,82899	9,86820	9.96078	10.03921	35
27	6749	7378	9147	1,093	9,82926	9,86797	9,96129	10,03870	33
29	6753	7374	9157	1,091	9,82954	9,86774	9,96179	10.03820	31
31	6758	7370	9168	1,090	9,82982	9.86751	9,96230	10.03769	29
33	6752	7366	9179	1,089	9,83009	9,86728	9,96281	10,03718	27
35	6766	7362	9190	1,088	9,83037	9.86705	9,96332	10.03668	25
37	6770	7359	9200	1,086	9,83064	9.86681	9.96382	10.03617	23
39	6775	7355	9211	1,085	9,83092	9,86658	9.96433	10.03566	21
41	6779	7351	9222	1,084	9,83119	9,86635	9,96484	10.03515	19
43	6783	7347	9233	1,083	9,83146	9,86612	9,96534	10,03465	17
45	6785	7343	9243	1,081	9,83174	9,86588	9,96585	10.03414	15
47	6792	7339	9254	1,080	9,83201	9,86565	9,96636	10.03363	13
49	6796	7335	9265	1,079	9,83228	9,86541	9,96686	10,03313	11
51	6800	7331	9276	1,078	9,83256	9,86518	9,96737	10,03262	9
53	6805	7327	9287	1,076	9,83283	9,86495	9,96788	10.03211	7
55	6809	7323	9297	1,075	9,83310	9,86471	9,96838	10.03161	5
57	6813	7319	9308	1,074	9,83337	9,86445	9,96889	10,03110	3
59	6817	7315	9319	1,072	9,83364	9,86424	9,96940	10,03059	1
		N,fi.		N,T.		Log, fi.		Log.tang,	M

88 Degrees

	N. S.	N, T.	Log. S,	Log. tan.
N,S, 20 ,59 is	3580	3835	9,55399	9,58379
N,S, 21 ,01 is	3586	3841	9,55465	9,58455
N,S, 21 ,00	7166	7676	19,10864	19,16834
	3583	3838	9,95532	9,58417

Hence Natural Sine is 3583, Natural Tangent 3838, Log. Sine 9,95432, Log. Tangent 9,53417, as required,

Example

43 Degrees.

M	N si.		N, T,		Log. si.		Log. T.		
1	6823	7311	9330	1,071	9,83391	9.86401	9,96990	10.03009	59
3	6820	7307	9341	1,070	9,83418	9,86377	9,97041	10,02958	57
5	6830	7303	9352	1,069	9,83446	9,86353	9,97092	10.02907	55
7	6834	7299	9363	1,068	9,83473	9,86330	9,97142	10,02857	53
9	6839	7295	9374	1,066	9,83499	9,86306	9.97193	10,02806	51
11	6843	7291	9385	1.065	9.83526	9,86282	9,97244	10,02755	49
13	6847	7287	9396	1,064	9,83553	9,86259	9.97294	10,02705	47
15	6851	7283	9407	1,063	9,83580	9,86235	9,97345	10,02654	45
17	6856	7279	9418	1,061	9,83607	9,86211	9,97396	10,02603	43
19	6860	7275	9429	1,060	9,83634	9,86187	9,97446	10,02552	41
21	6864	7271	9440	1,059	9,83661	9.86163	9,97497	10.02502	39
23	6868	7267	9451	1.058	9.83687	9.86140	9,97547	10,02452	37
25	6872	7263	9462	1.056	9,83714	9,86116	9.97598	10.02401	35
27	6877	7259	9473	1,055	9,83741	9,86092	9,97649	10.02350	33
29	6881	7255	9484	1,054	9,83767	9.86068	9,97699	10.02275	31
31	6885	7251	9495	1,053	9,83794	9,85044	9,97750	10.02249	29
33	6889	7247	9506	1,051	9,83821	9,85020	9,97800	10,02199	27
35	6894	7243	9517	1,050	9.83847	9,85996	9.97851	10.02148	25
37	6898	7239	9528	1,049	9,83874	9,85972	9.97902	10.02097	23
39	6902	7235	9539	1,048	9.83900	9,85948	9.97952	10.02047	21
41	6906	7231	9550	1,047	9,83927	9,85923	9,98003	10,01996	19
43	6910	7227	9561	1,045	9,83953	9.85899	9,98053	10,01946	17
45	6915	7223	9572	1,044	9,83980	9,85875	9,98104	10,01895	15
47	6919	7219	9584	1,043	9,84006	9,85851	9,98155	10.01845	13
49	6923	7215	9595	1,042	9,84032	9,85827	9,98205	10.01794	11
51	6927	7211	9606	1,040	9,84059	9.85802	9,98256	10.01743	9
53	6931	7207	9617	1,039	9,84085	9,85778	9,9830	10.01693	7
55	6936	7203	9628	1,038	9,84111	9,85754	9,98357	10,01632	5
57	6940	7199	9640	1,037	9,84137	9,85730	9,98407	10,01592	3
59	6944	7195	9651	1,036	9,84164	9,85705	9,98458	10,01541	1
		N,si.		N,T.		Log, si.		g.tang,	M

46 Degrees

Example 5th; Required to find the natural Sine, and natural Tangent, Log, sine and Log, Tangent of 54,28

Find their Natural and Logarithmic Sine and Tangent, for the next above and below 5428, as in the next page.

44 Degrees.

M	N, ti,		N.T.		Log, S,		Log, T		
1	6948	7191	9662	1,034	9,84190	9,85681	9,98509	10,01491	59
3	6952	7187	9673	1,033	9,84216	9,85656	9,98559	10,01440	57
5	6957	7183	9683	1,032	9,84242	9,85632	9,98610	10,01389	55
7	6961	7179	9696	1,031	9,84268	9,85607	9,98660	10,01339	53
9	6965	7175	9707	1,030	9,84294	9,85583	9,98711	10,01288	51
11	6969	7171	9718	1,028	9,84320	9,85558	9,98761	10,01238	49
13	6973	7167	9730	1,027	9,84346	9,85534	9,98812	10,01187	47
15	6977	7163	9741	1,026	9,84372	9,85509	9,98862	10,01137	45
17	6982	7158	9752	1,025	9,84398	9,85485	9,98913	10,01086	43
19	6986	7154	9764	1,024	9,84424	9,85460	9,98964	10,01036	41
21	6990	7150	9775	1,022	9,84450	9,85435	9,99014	10,00985	39
23	6994	7146	9787	1,021	9,84476	9,85410	9,99065	10,00934	37
25	6998	7142	9798	1,020	9,84501	9,85386	9,99115	10,00884	35
27	7002	7138	9809	1,019	9,84527	9,85361	9,99166	10,00833	33
29	7007	7134	9821	1,018	9,84553	9,85336	9,99216	10,00758	31
31	7011	7130	9832	1,017	9,84579	9,85311	9,99267	10,00732	29
33	7015	7126	9844	1,015	9,84604	9,85286	9,99317	10,00682	27
35	7019	7122	9855	1,014	9,84630	9,85262	9,99368	10,00631	25
37	7023	7118	9867	1,013	9,84656	9,85237	9,99418	10,00587	23
39	7027	7114	9878	1,012	9,84681	9,85212	9,99469	10,00530	21
41	7031	7110	9890	1,011	9,84707	9,85187	9,99519	10,00480	19
43	7036	7105	9901	1,009	9,84732	9,85162	9,99570	10,00429	17
45	7040	7101	9913	1,008	9,84758	9,85137	9,99621	10,00379	15
47	7044	7097	9924	1,007	9,84783	9,85112	9,99671	10,00328	13
49	7048	7093	9936	1,006	9,84809	9,85087	9,99722	10,00277	11
51	7052	7089	9947	1,005	9,84834	9,85061	9,99772	10,00227	9
53	7056	7085	9959	1,004	9,84859	9,85036	9,99823	10,00176	7
55	7060	7081	9970	1,003	9,84885	9,85011	9,99873	10,00126	5
57	7064	7077	9982	1,001	9,84910	9,84986	9,99924	10,00075	3
59	7069	7073	9994	1,000	9,84935	9,84961	9,99974	10,00025	1
		N.ti		N,T,		Log. ti.		Log,tang,	M

45 Degrees

N.S, 54 ,27 is 8136	1,399	9,91041	10,14593
N,S, 54 ,29 is 8139	1,401	9,91059	10,14646
16275	2,800	19,82100	20,29239
8137	1,400	9,91050	10,14619

Hence the Natural Sine of 54 ,28 is 8137, its Natural Tangent is 1,400, its Log. S. is 9,81050, Log. Tangent 10,14619, as was required.

A TABLE

A TABLE of the Angles which every Rumb or Point of the Compaſs, makes with the Meridian.

North.	South.	P.	D. M.	North	South
		¼	2 49		
		½	5 37		
		¾	8 26		
N. by E.	S. by E.	1	11 15	N. by W.	S. by W.
		1¼	14 04		
		1½	16 52		
		1¾	19 41		
N. N. E.	S. S. E.	2	22 30	N. N. W	S. S. W.
		2¼	25 19		
		2½	28 07		
		2¾	30 56		
N. E. b N.	S. E. b. S.	3	33 45	N. W. b. N.	S. W. by S.
		3¼	36 34		
		3½	39 22		
		3¾	42 11		
N. E.	S. E.	4	45 00	N. W.	S. W.
		4¼	47 49		
		4½	50 37		
		4¾	53 26		
N. E. b. E.	S. E. b. E.	5	56 15	N. W. b W.	S. W. b. W.
		5¼	59 04		
		5½	61 52		
		5¾	64 42		
E. N. E.	E. S. E.	6	67 30	W. N. W.	W. S. W.
		6¼	70 19		
		6½	73 06		
		6¾	75 57		
E. by N.	E. by S.	7	78 45	W. by N.	W. by S.
		7¼	81 34		
		7½	84 22		
		7¾	87 11		
East	East	8	90 00	West.	West.

THE

THE

APPENDIX;

Wherein is ſhown how to work all the Caſes in Navigation, by the Pen Arithmetically, without Books, Tables or Inſtruments.

The GENERAL RULES of this METHOD.

IN Order to a right underſtanding of this method of Trigonometry, I ſhall proceed according to the uſual method; and ſhall, for the help of the memory, lay down fundamental rules or axioms, upon which the whole operation depends, and by which all the caſes in plain Trigonometry, both right and oblique may be ſolved, without either Book, table, or inſtrument whatſoever.

But before I come to the axioms, I ſhall premiſe that when ever a ſide and an angle is given, to find another ſide (which is the firſt, and moſt uſeful caſe in navigation) here muſt be a number found, which is called the natural Radius, not only becauſe it is the original, from whence the ſolutions are deduced; but alſo, becauſe being found, it produceth the ſame anſwer as in natural number, that the Radius or ſine of 90 produceth in a ſinical proportion. And this natural Radius is thus found.

Method the Firſt.

Take the angle whoſe oppoſite ſide is either given or ſought, and divide four times the ſquare of its complement to 90 degrees by 300 added to three times the ſaid complement, and then the quotient added to the ſaid angle, is the natural Radius required; and this Rule is univerſally true in all angles from 0 to 90.

Method

Method the Second.

But becauſe in the angles under 45, the complements are above 45 and their ſquares amount to greater numbers than the ſquares of the complements of the angles above 45, therefore to render the work as eaſy and the contrivance as uſeful as poſſible, I ſhall ſhew another way to find the natural Radius, for all angles under 45. And the general rules is,

Divide three times the ſquare of the angle (whoſe oppoſite ſide is given or ſought) by 1000, and to the quotient add 57.3, that is 57 and 3 tenths, the ſum is the natural Radius required. This being promiſed the rules are theſe.

Rule 1ſt. In right angled Triangles, Suppoſe an angle and a ſide be given to find another ſide.

The Natural Radius bears always the ſame proportion to the hypothenuſe that the angle by which the Natural Radius was found, bears to its oppoſite ſide, therefore if the angles and hypothenuſe be given; it is, As Natural Radius, to the hypothenuſe, ſo is the angle, to its oppoſite ſide; but if the angle and a leg be given, then it is, As angle is to its oppoſite ſide, ſo is NaturalRadius, to the hypothenuſe.

Rule the 2d. in right angled triangles the two ſides given, to find a third.

The hypothenuſe is equal in power to two legs, that is, the ſquare of the hypothenuſe is equal to the ſum of the ſquares of the two legs, of which ſee more further on.

Rule 3d. In right angled triangles the hypothenuſe and a leg given, to find the other leg.

Multiply the ſum of the hypothenuſe and the given leg by their difference, and the ſquare root of the product is the other leg required.

Rule 4th. In right angled triangles, three ſides being given, to find an angle.

Add half the longer leg to the hypothenuſe, Then, As that ſum is to 86, So is the ſhorter leg, To its oppoſite angle.

Three ſides being given to find where the perpendicular muſt fall.

Multiply the ſum of the two ſhorteſt ſides by their difference, and

divide the product by the third ſide, which is the greateſt, and upon which the perpendicular is to fall, the quotient added to the greater ſide, or ſubſtracted from it, ſhall be double the greater or leſſer ſegments on each ſide of the perpendicular.

Rule 2d. Add the ſquares of the biggeſt and leaſt ſides together, and from their ſum, ſubſtract the ſquare of the middlemoſt; half the remainder divided by the greateſt ſide, the quotient is the leſſer ſegment, which ſubtracted from the whole baſe leaves the greater ſegment.

Plain Sailing by this Method.

I ſhall now proceed to ſome examples in right angled triangles, applied to plain ſailing; and here note, that to avoid fractions, I ſhall prop the given angle always in degrees, that being ſufficiently exact in all caſes in Navigation; and a far more exact way than reckoning by points; one degree being a much ſmaller part of a great circle than a quarter of a point of the compaſs; And I ſhall make uſe of degrees rather than quarter points, not only for its exactneſs, but alſo becauſe it is a method much in uſe aboard of the Men of War, to reckon the courſe in degrees and not in points and quarter points.

Caſe 1ſt. The courſe and diſtance given, to find the difference of latitude and departure.

Example. Suppoſe a ſhip ſails S. E. by S. 207 miles; I demand her difference of latitude and departure.

S. E. by *S.* equal 33 ,75 in Deg.
∠ courſe 33 .75

16875
23625
10125
10125

Sq. ang. 1139,0625
3

product 3417,1575 divide by 100 gives 34,17
To which add 57,3

Sum is 60,7 the Natural Radius

Then, as natural Radius 60,7,
Is to the diſt. 207, So is S. cour.
33,75 to the dep. 33,75
207.

23625
67500

60.7,6986,25(115 miles, the depar.
607

916
607

3052
3035

575

Then

Then to find the difference of Latitude.

Diſtance	207	Product	29624	(172 miles =
Departure	115		1	X of lat.
Sum	322		2)196	
Difference	92		189	
	644		35) . . 724	
	2898		704	
Product	29624	(172 m.	20	

Caſe 2d. The courſe and difference of latitude being given to find the diſtance and departure.

Suppoſe a ſhip in latitude 48 ,30 N. ſails N W half W. or north 53 ,8 W. until by obſervation, ſhe is in Latitude 53 ,49 N. I demand her diſtance and departure.

In this example, the ſide oppoſite to the leſſer angle is given, therefore we work by the ſecond general Rule of finding the natural Radius; as the angle oppoſite to the given ſide is under 45 degrees.

Latitude	53 ,49	Great angle	50 ,38
Latitude	48 ,30	Leſſer angle	39 ,22
60 X by	5 ,19	In Decimals 50 ,63 and 39 ,36	
X of Latitude	319	To find the Diſtance, As the leſſer angle, Is to the oppoſite ſide : : So is natural Radius : To the Diſtance.	
	39 ,4		
	39 ,4	39.4 : 39 : : 62	
	1576	02	
	3546	638	
	1182	1914	
3 X by	1552, 6	39.4) 1977 (502 the diſtance required.	
	465 ,08 this		
divide by	1000 Quotes		
	4,657		
	57.3 Add		
	61.957 or 62		

For

For the Natural Radius.

Diſtance	502
Difference of Lat.	319
Sum	821
Difference	183
	2463
	6568
	821
	150243

To find depar. or diff. of merid.

150243(387,6 The departure required.
3
6)602
544
76)5543
5369
774)47700
46676
924

Example 2d. Suppoſe a ſhip in latitude 50 ,49 N. fails S. E. by S. 1 quarter S. until by obſervation, ſhe is in Latitude 48 ,30 N. I deſire to know what is her diſtance and departure.

Latitude 50 ,9
Latitude 48 ,30
2 ,6
60
Diff. of Lat. 139

∠ 36 ,34 } in Decimals { 36 ,56
∠ 53 ,26 } { 53 ,43

Here the ſide oppoſite to the greater angle is given, then it is moſt proper to uſe the firſt General Rule, To find the natural Radius,

36 ,56
36 ,56
21936
18280
2936
10968
13366,36
4
53360,5344

36,56
3
109,68
200
409,68)8356,53(13 ,06
53 ,43
66 ,49

The greater ∠ added to the quotient gives 66,49 the natural Radius

To find the departure or Difference of meridion.

Diſtance 173
diff. of lat. 139
Sum 312
Difference 34
1248
936
10608(103
1
20)10608
609
The departure 103 neareſt.

To find the diſtance.

As the greater Angle 53 ,43
Is to its oppoſite ſide 139
So is Natural Radius 66 ,49
To the diſtance
viz. $\frac{66,49 \times 139}{53,43} = 172,7$
or 173 neareſt the diſtance Required.

Caſe 3d.

Caſe 3d. The Courſe and departure being given, to find the diſtance and difference of latitude.

Example. Suppoſe a ſhip in Latitude 31 ,19 N. ſails N. W. by N. half W. making her Departure 188 miles; Required her diſtance run, and difference of latitude and the latitude ſhe is come to?

Here the departure being the ſhorter Leg, is given, therefore we ſhall find the natural Radius by the ſecond general rule.

N. W. by N. half W. equal 39 ,22 in Decimals equal 39 ,36

39.36
39,36

236.6
11808
35 24
11801

1549206
3

4647 6288 this divide
---- — by 1000
4,647 +
573

61,947 = Natural Radius or
61,95 will do.

To find the Diſtance, ſay,

As s. given angle in decimal
Is to the given departure,
So is Natural Radius
To the diſtance
89 ,36 : 188 : : 61 ,95 that is
61,95 × 188
---------- equal 293,1 mi.
39,36
the diſtance required.

To find the diff. of Lat.

Diſtance	293	Sum	481
Departure	188	Differ.	105

2405
4810

Whoſe ſquare Root is 224 } 50505

Anſwer, Diſt. 293,1 miles, Diff. of latitude 224 miles as required.

Caſe 4th. The diſtance and difference of Latitude being given to find the courſe and departure.

Suppoſe a ſhip ſails in the s w. quarter from the Latitude 35 ,02 N. making her diſtance 289 miles and then by obſervation is in Latitude 31 ,19 N. what courſe has ſhe ſteered, and what is her departure.

To find the Departure by the 3d Rule.

Diſtance	289	33792(184	Latitude	35 ,02
Diff. of Lat.	223	1	Latitude	31 ,19
	512	2)247		3 ,43
	66	224		60
	3072	1392	Diff. of Lat.	223
	3072	Hence the Departure is 184 m. nearly.		
	33792			

To

To find the Courſe.

The diſtance	289	400 : 86 :: 184 : $\frac{184 \times 86}{400}$
Half longer Leg.	111	$= 39\frac{221}{400} = 39,33$ or s. w. by s. half w. QEI
	400	

Caſe 5th. The Diſtance and departure being given to find the course and difference of latitude.

Example. Suppoſe a ſhip in the latitude of 40 ,15 ſails in the N. E. quarter 215 miles, until her departure or eaſting is 77 miles, I deſire to know the courſe ſhe has ſteered and Latitude ſhe is come to?

To find the difference of latitude by the traverſe rule,

Diſtance	315	
Departure	277	
Sum	592	
Difference	38	
Lat. dep	40 15 N.	47 30
Co. Lat.	2 30	17-6
42 45 —	2)2249,49,9	
Lat. come to	1	or 150 the
		× of Lat
28)	124	required.
	94	
298)	2896	
	2601	
	29500	

To find the Courſe by the laſt queſtions method.

Diſtance	315
Half the departure	138 5
Sum is	453,5

Then as 453,5 : 86 : So is the difference of latitude (being the ſhorteſt leg) to its oppoſite angle, the complement of the Courſe, viz.

$453,5 : 86 :: 150 : \frac{150 \times 86}{453,5}$

equal 28 ,26 and 90 ,00 — 28 ,26 equal 61 ,34 the courſe

Anſwer.

Courſe N 61 ,34 Eaſterly, or N E. by E. half E. neareſt.

Difference of Lat.	150 miles
Latitude come to	42 ,45 N.

Caſe 6th. The Difference of latitude and departure being given, to find the courſe and diſtance.

Suppoſe a ſhip in latitude 50 ,33 N. ſails in the S. W. quarter, until her difference of latitude be 22 miles, and departure 108 miles; I demand the courſe and diſtance, and latitude come to.

For

For the Distance by Rule 2d

220 × 220 equal 48400 equal Sq. diff. of Latitude.
108 × 108 equal 11664 equal Sq. departure. Hence the distance is 245

Their sum is 60064

Distance 245
Half × of Lat. 180
Sum 355

For the course by Rule 4th.

$355 : 86 :: 108 : \frac{108 \times 86}{355}$

equal 26,09 the course

60064(245
4
4)200
176
2;64
2425
39

Section 2d. How to find the difference of longitude and keep a reckoning both in Latitude and Longitude by this method of Trigonometry, as applied to Navigation, without the help of any tables or instruments whatsoever, according to middle latitude, which is of sufficient exactness for the working of a day's run, and so will be of great use in navigation.

The young Navigator will please to remember, that in middle Latitude sailing Trigonometrical, there is a proportion for finding the difference of Longitude, which is, As sine comp. of middle latitude, Is to the departure, So is Radius, To the difference of longitude. And therefore, in middle latitude sailing Geometrical, I have there proposed a method for projecting middle latitude sailing, which is by constructing a right angled plain triangle, whose angle at the base is equal to the complement of the middle latitude, and the perpendicular is equal to the departure, and then by the known properties of opposite sides, and opposite angles, it follows that the hypothenuse must needs represent the difference of longitude; which being granted, there is no more to do for finding the difference of Longitude, but only the solution of the said right angled triangle of the several varieties, of which you have had sufficient instances in the first rules of plain sailing beforegoing, where any two parts being given, the other two are easily found. Nevertheless, that nothing may be wanting for the Navigators instruction, I shall instance in one question for example sake, which I shall first work by this new method, and shall then by the method proposed in mid. lat. sailing Trigonometrical, and lastly shall work the same by Mercator, to shew the Reader the sufficiency and exactness of this most useful invention.

Question. A ship in Latitude 58,5ϵ N. sails S. 51,10 westerly, 256 miles; I desire to find her latitude come to, and likewise her departure and difference of Longitude.

Opera-

Operation. $\left.\begin{matrix}51,19 \text{ or } 51,31\\ 38,41 \text{ or } 38,68\end{matrix}\right\}$ In Degrees and Decimals

Then $\frac{36,68 \times 26,58 \times 3}{1000} + 57,3 = 61,78$ N. Radius

Then 61,78 : 256 :: 51,31 : $\frac{256 \times 51,31}{61,78}$ equal 212,5 her Depar.

And 61,78 : 256 :: 38,68 : $\frac{256 \times 38,68}{61,78} = 160$ the × of Latitude.

60)160(2,40
Sub. from 58,5
lat. come to 56,16
115,12

$\frac{115,2}{2} = 57,36$
C. M. Lat. 32 24

To find the Natural Radius answering.

Com. Mid. Lat. 32,24 = 32,4
Then $\frac{32,4 \times 32, \times 3}{1000} +$
57,3 equal 68,4 the N. Radius.

Then becauſe the hypothenuſe or Diff. of Long. is required.
As C. M. Lat. : M. Diſt. :: Radius : Diff. of Long. viz.
3,4 : 212,5 :: 60,4 :
$\frac{60, \times 212.5}{3,4} = 396,4$ the diff. of longitude.

To find the difference of long. by middle Latitude.

As S. C. M. L.	212,5
To the diff. of mer.	212,5
So is Radius	90,00
To diff of Long.	396,6

miles as required.

Here the diff. of longitude found by this method is 396,4, found by middle latitude 396.6 the diff. between them being inconſiderable.

Here it evidently appears that this method will perform the work of all the ſeveral kinds of ſailing, and alſo to find the difference of longitude, without either Books tables, or inſtruments.

FINIS.